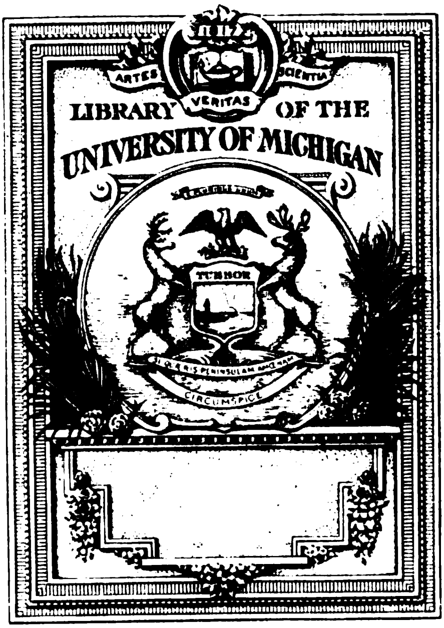
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State of Rhode Island and Providence Plantations.

FIRST ANNUAL REPORT

OF THE

BOARD OF MANAGERS

OF THE

Rhode Island State Agricultural School and Experiment Station

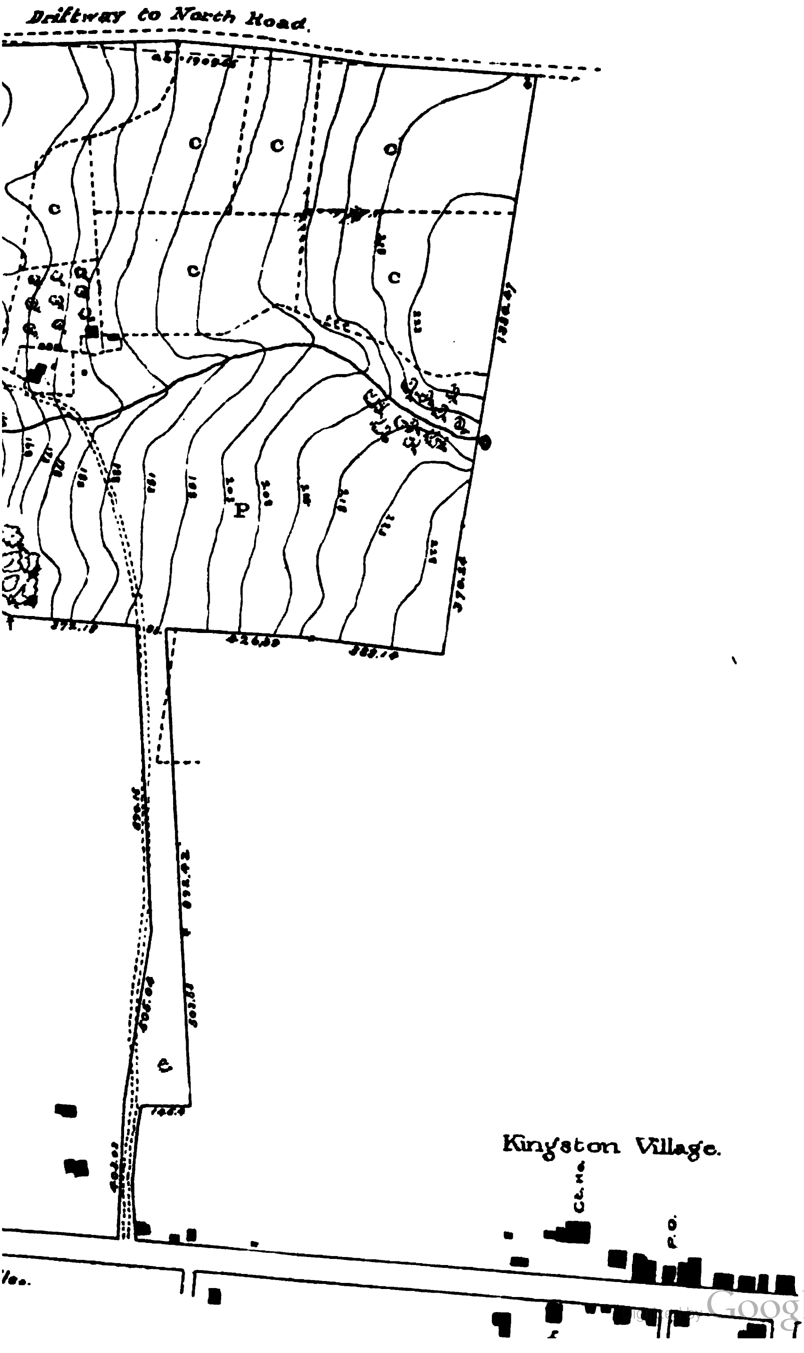
MADE TO THE

GENERAL ASSEMBLY,

AT ITS

JANUARY SESSION, 1889.

PROVIDENCE:
E. L. FREEMAN & SON, STATE PRINTERS.
1889.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MEMBERS OF THE BOARD OF MANAGERS

OF THE

R. I. State Agricultural School and Experiment Station.

Charles O. Flagg	Providence County	5 years.
Charles J. Greene	Washington County	4 years.
Melville Bull	Newport County	3 years.
C. A. Shippee, of W.	Kent County	2 years.
C. H. Coggeshall	Bristol County	1 year.

OFFICERS.

Charles O. Flagg	Abbott Run, R. I.	Pres. and Director, *pro. tem.*
Melville Bull	Newport, R. I	Secretary and Treasurer.

General

REPORT.

To the Honorable the General Assembly of the State of Rhode Island, at its January Session, 1889.

In making this, the first annual report of the Board of Managers of the Rhode Island State Agricultural School, we trust it may not be inappropriate to very briefly review the influences which have brought about the passage of the Act of the General Assembly of this State, March 23d, 1888.

GOVERNMENT AID TO EDUCATIONAL INSTITUTIONS.

The idea of the higher education came to American soil with the Pilgrim Fathers, for hardly had their feet pressed Plymouth Rock when out of their poverty a year's rate of the Colony was levied, that the germ of a college should be planted in the new world. The solicitous care of the colony is ever manifest through the vicissitudes of those early days, and the pages of legislative record up to the memorable days of Independence bear evidence by more than a hundred different statutes of its nurture and guidance.

What is true of Harvard is essentially true of Yale, for the General Court of Connecticut had carefully considered the founding of such an institution long before Elihu Yale gave the final impulse which resulted in the establishment of the college which bears his name, some sixty years after the planting of Harvard.

The support of Yale college previous to the present century was largely due to the bounty of the legislature of Connecticut, says the first President Dwight in his history. The second college established

in the Colonies, the William and Mary of Virginia, was founded and supported through colonial days from the public treasury.

In our own State the fear that in some way educational institutions might interfere with that perfect individual religious freedom of thought and action which was the central motive that brought Roger Williams to settle Providence Plantations, seems to have caused division of opinion among the early settlers and time passed on till 1762, when James Manning was instrumental in an effort to procure a charter for the establishment of a University in Rhode Island, upon a broad basis of religious freedom.

This effort was doomed to defeat through religious jealousy; but two years later, in February, 1764, a charter was granted, but we find no record of educational work until 1766, when eight students were instructed in the town of Warren, and the first commencement dates from September 7, 1769. A proposition to build in Warren led to an agreement to locate in the county which might raise the most money in support of it, and February 7, 1770, it was voted to build the college edifice "in the town of Providence, and there to be continued forever."

GRADUATES, PROFESSIONAL MEN.

The minister, the lawyer, the doctor, the scholar and perhaps the merchant were graduates of these colleges. The sons of farmers, merchants and professional men entered their halls to go forth into the so-called professions. The idea that the son of the farmer intending to follow his father's vocation, the youth whose ambition was to become a builder, a blacksmith, a wheelwright or cabinet maker, required any other training than a smattering of the "three R.'s" and a thorough seven years' apprenticeship in the manual labor of the field or workshop had not been advanced by even the most liberal educationalists on this or the other side of the water.

WASHINGTON ADVOCATES AGRICULTURE.

It remained for the Father of his Country—and is it not an additional evidence of the far-seeing wisdom of this remarkable statesman and

farmer as well—to say in his annual message at the second session of the Fourth Congress, December 7, 1796, just a year after the organization of the first industrial and technical school in Europe, these words:

"It will not be doubted that with reference either to individual or national welfare, agriculture is of primary importance. In proportion as nations advance in population and other circumstances of maturity this truth becomes more apparent and renders the cultivation of the soil more and more an object of public patronage. Institutions for promoting it grow up supported by the public purse; and to what object can it be dedicated with greater propriety.

Among the means which have been employed to this end, none have been attended with greater success than the establishment of Boards composed of public characters charged with collecting and diffusing information, and enabled by premiums and small pecuniary aid to encourage and assist a spirit of discovery and improvement. This species of establishment contributes doubly to the increase of improvements by stimulating to enterprise and experiment and by drawing to a common centre the results everywhere of individual skill and observation and spreading them thence over the whole nation.

Experience accordingly has shown that they are very cheap instruments of immense national importance."

NATIONAL BOARD OF AGRICULTURE.

The propositions for a National University and a National Board of Agriculture made about this time were referred to a committee, but never heard from after. A few agricultural societies had been already organized, the earliest in Philadelphia in 1785, the Massachusetts Society for promoting Agriculture, incorporated March 7, 1792, and one in New York and another in North Carolina with some others doubtless, before the present century began.

In 1817 a memorial was presented to Congress through the efforts of members of Berkshire, Mass., Agricultural Society in favor of a National Board of Agriculture. The favorable report of the committee to

which it was referred was ably seconded by some, but opposed by the large majority and defeated.

Finally a National Agricultural Department came into being in connection with the Patent Office about 1837. The Rhode Island Society for the Encouragement of Domestic Industry has been a stimulus to the industrial and agricultural business of the State since 1820. Local societies sprang up in all sections of the country.

INVENTION STIMULATES AGRICULTURE.

Many and varied influences were at work turning the attention of public men to the agriculture of the country. The possibilities of steam transportation by sea and land were just unfolding. Better postal facilities and more rapid transportation of mails gave an unbounded impetus to the publication of papers and literature of all kinds, stirred the minds and quickened the thoughts of the people.

The discovery of gold in California and the subsequent tide of emigration westward, the tireless spirit of invention which strove on every hand so successfully to substitute the machine for man and steam for muscle, reached the hitherto almost untouched field of agriculture. I mproved plows, cultivators and harrows were made, mowing machines invented, horse rakes, tedders, reapers, self-binders, etc., etc., came in rapid succession with numberless improvements, till now the number and variety of farming tools is legion.

AGRICULTURAL SCHOOLS OF EUROPE.

Meanwhile the elaborate report on the agricultural schools of Europe by Mr. Chas. L. Fleischmann in the Patent Office report for 1847, and of Dr. Hitchcock, commissioned by the State of Massachusetts in 1851 to examine the agricultural schools of England, France and Germany and report thereon, together with spasmodic efforts in some sections of our own country looking toward the establishment of some agricultural school or college, formed a leaven which was slowly but steadily doing its work on public opinion. Again, observing minds had been a little startled and troubled to find from the census reports of the

United States, that our lands all through the country were generally deteriorating, the successive census statistics showing a less and less number of bushels of cereals per acre in nearly all the States.

LAND GRANT ACT INTRODUCED IN CONGRESS.

These facts led the Hon. Justin S. Morrill, then a National Representative from Vermont, on the 14th of December, 1857, to introduce a bill which provided for the issue of land scrip to the several States and Territories at the rate of 20,000 acres for each Senator or Representative in Congress for the purpose of founding a college in each, where such branches should be taught as are most intimately related to agriculture and the mechanic arts.

The Committee on Public Lands reported against this bill about four months later, but Mr. Morrill ably and eloquently defended his cause and perseveringly worked for his bill. Fourteen months after it was offered it had successfully passed both branches of Congress and awaited the signature of President Buchanan to become a law. It was returned with the President's veto and the veto was sustained, although the objections were satisfactorily answered by Mr. Morrill.

PASSAGE OF LAND GRANT ACT.

In December, 1861, he again offered a bill providing for 30,000 acres of the public lands for each Senator and Representative, and it was referred to the Committee on Public Lands.

It was not until May 29, 1862, that Mr. Potter of Wisconsin reported against it, and it was referred to the committee of the whole. On the 2d of May, before the House Committee had reported unfavorably, Hon. Benjamin Wade of Ohio offered a bill essentially the same, which was referred to the *Senate* Committee on Public Lands, Senator Harlan of Iowa, Chairman. With admirable promptness on the 14th of May he reported the bill with trifling amendments, and on June 10th it passed the Senate without active opposition. The following day the bill went to the House, and although strongly opposed by the Committee on Public Lands, passed on June 19th, and became a law with the signature of Abraham Lincoln, July 2, 1862.

PROVISIONS OF THE ACT OF 1862.

This Act gave each State, "for the purpose hereinafter mentioned," 30,000 acres of public land for each Senator and Representative in Congress, not including any mineral lands.

Section 2 provides the manner in which the lands should be set off and "said scrip to be sold by said States and the proceeds thereof applied to the uses and purposes prescribed in this Act, and *for no other purpose whatsoever.*"

Section 3 provides that the State shall pay out of the Treasury all expense of locating, sale and management of funds, "so that the entire proceeds of the sale of said lands shall be applied without any diminution whatsoever to the purposes hereinafter mentioned."

Section 4 provides for the investment of the funds derived from sale of the land scrip in stocks of the United States or of the State or some other safe stocks yielding not less than five (5) per centum upon the par value of said stocks, and that the moneys so invested shall constitute a perpetual fund, the capital of which shall remain forever undiminished (except so far as may be provided in section fifth of this Act) and the interest of which shall be *inviolably appropriated* by each State which may take and claim the benefit of this Act, to the *endowment*, *support* and *maintenance* of at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislature of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life.

Section 5 names the conditions "to which, as well as the provisions hereinbefore contained, the previous assent of the several States shall be signified by legislative acts."

CONDITIONS OF THE ACT OF 1862.

The first condition requires the State to replace any portion or interest thereon which by any action or contingency be diminished or lost,

and allows ten per centum (10) of the original fund to be used for the purchase of lands for sites or experimental farms, whenever authorized by the respective legislature of said States.

The second forbids the use of any portion of the fund or interest in the "erection, preservation or repair of any building or buildings."

The third requires that the college be provided within five (5) years, or the fund turned over to the United States.

The fourth is "An annual report is to be made regarding the progress of each college, recording any improvements and experiments made, with the costs and results, and such other matters, including state, industrial and economical statistics, as may be supposed useful; one copy of which shall be transmitted by mail, free by each, to all the other colleges which may be endowed under the provisions of this Act, and also one copy to the Secretary of the Interior."

The sixth excluded any State in a condition of rebellion from the benefits of the Act, and the seventh required the States to accept the conditions of the Act by legislative action within two years of its approval by the *President* to be entitled to its benefits.

Sections 6, 7 and 8 relate to the locating, price and sale of the lands.

AMENDMENTS TO ACT OF 1862.

An additional Act, amending section five of the Act of 1862, was passed July 23, 1866, extending the time allowed for acceptance of the benefits of said act three (3) years, and allowing five (5) years after the original five named in the Act for the establishment of a college. Also providing the method by which Territories becoming States might obtain the benefit of the Act.

This time of acceptance by the States was further extended by another amendment to two years from July 1st, 1872.

"*With which to provide at least one college as described in the 4th section of an Act entitled 'An Act donating,' &c., approved July 2d, 1862.*"

These are the main facts of the United States statutes under which Agricultural Colleges or Agricultural departments in Classical colleges

have been organized and endowed in most if not all the States in the Union.

FIRST AGRICULTURAL COLLEGE.

In some States an effort, and more than effort, had been made in this same line. Several hundred farmers and planters, residents of the State of Maryland, personally contributed a large fund and established the first agricultural college in the United States in 1857 at the station and post-office by that name eight (8) miles out of the city of Washington, but political appointments, frequent changes in and often inefficient management, together with the apparent absence of any adequate idea of the true aims and purposes of such an institution, has often made it an object of suspicion and ridicule with the farmers themselves, and almost unknown outside the boundaries of its own State. However, "It's a long lane that has no turning," and within a year one of the best organizers in the country has been placed at the helm and with an efficient corps of helpers, if his efforts are seconded by the trustees, as they doubtless will be, the future promises results to the agriculture of Maryland well worth the long and tedious waiting.

The Michigan Agricultural College, founded about the same time, graduated its first class in 1861, and has ever had an enviable reputation as one of the best in the country. Both these colleges received the United States land grant endowment. The Massachusetts Agricultural College and Cornell University, Ithaca, N. Y., were two of the many that came into existence under the impulse of the Act of 1862. In Massachusetts one-third of the interest on the fund of $219,000, derived from the sale of the land scrip allotted to that State, is paid by law to the Institute of Technology at Boston, thereby relieving the Agricultural College, which receives the other two-thirds, from any obligation under the Act of '62, to teach "the mechanic arts."

INDUSTRIAL TRAINING.

In many of the other colleges the department of Mechanic Arts is being more fully developed by providing industrial training under

skilled mechanics, who are qualified to teach the "science" as well as the "labor" in the departments which they supervise. Cornell University has long had such facilities for training the mind and eye, as well as the brain, and many of the western agricultural colleges are leading in this department of education. The University of Tennessee has just completed a brick building, provided with a twenty-five horse power boiler and engine of the most approved pattern—six forges with blowers so arranged as to take off all the smoke, iron-turning, drilling and planing machinery with all the improvements to date—in an adjoining room a dozen wood-turning lathes, saws, planer, etc.; a third apartment is provided with benches, vises, and hand wood-working tools, each student having five or six feet of bench room, a vise and kit of tools. There are also in the building rooms where free-hand and mechanical drawing are taught, and all the work done in the shops must first be designed and placed on paper, then constructed according to the plans.

That the idea of industrial training, barely outlined in the Land Grant Act of 1862 is receiving the support and encouragement of our best educators and public men, is evident to all. That part relating to the public schools of the inaugural address of the Hon. Henry R. Barker, Mayor of Providence, and the address of President Rowland Hazard, before the South County Agricultural Society at its annual fair last fall, is evidence of the interest in this subject in this State.

At this point it may be well to ask of the Act of 1862

HAS THE END JUSTIFIED THE MEANS?

Do Agricultural Colleges educate young men toward, or away from the farm? For we hear these questions now, although less frequently than ten years ago. The land grant amounted to 17,430,000 acres, which realized, as reported, about $7,545,405. In some States the fund received large additions from private endowments, New York State being most fortunate in this respect in an increase from about $600,000 to more than $6,000,000.

Many of the States also have assisted the colleges liberally from time

to time. Is it fair, not twenty-seven years after the passage of the Act endowing these colleges, to ask if the *end* justified the means ? Surely the "end" is not yet, and look at the results attained when the purpose and intention—the spirit as well as the letter of the Act of '62 has been faithfully carried out. Professor A. J. Cook, of the Michigan Agricultural College, in a recent article in the *Country Gentleman*, gives the manual labor feature of that institution large credit for sending "such a surprisingly large proportion of its graduates on to farms . . . and determining the future of the large number of our graduates that are now acting as professors in agricultural colleges and that are employed in the several experimental stations. Twenty-eight of our graduates are professors in Agricultural colleges or State Universities, twenty-three are members of experimental stations, and five are directors of such stations. while two are presidents of colleges."

The Massachusetts Agricultural College in 1887, sixteen years from the time the first class graduated, had a total of 268 graduates, of which number 260 were living. Eighty-four of them (32½ per cent.) were classed as engaged in "agricultural pursuits;" chemists and teachers, 17 each; engineers, 18; veterinary surgeons, 6; journalists, 8; clergymen, 4; physicians, 11; army, 1; lawyers, 9; dentists, 1; architects, 1; miscellaneous and unknown, 13; while 70 are assigned to business pursuits, several being in the fertilizer trade and intimately connected with agriculture. At the present time 28 of her graduates are connected with experiment stations in some official capacity.

Compare these results, if you please, with a like period of the early history of any of the classical colleges to which as a nation, we point with pride. Take Harvard, for instance; in 1643 there were four graduates; 1645, seven; 1646, four; 1652, one; 1654, one; 1655, two, and so on, whilst the class of 1685, consisting of fourteen, was the largest class graduated during the fifty years since "the college was begun," and twenty-two was the largest number of any class prior to 1719. Of the various investigations and experiments made at different times at the Massachusetts Agricultural College, that upon "the circulation of sap in plants and their expansive power during growth," led

the renowned Agassiz to say it alone was worth all the college had cost the Commonwealth.

EXPERIMENT STATION BILL INTRODUCED IN CONGRESS.

To increase the facilities for agricultural experiments and place the results before the people, a bill to establish agricultural experiment stations was introduced in the National House of Representatives by Hon. C. C. Carpenter, of Iowa, in the 47th Congress, 1881—1883. Nothing was done, however, and the Hon. A. J. Holmes, also of Iowa, introduced the same bill in the 48th Congress; but, fully occupied with other matters, little was done till Dr. G. W. Atherton, following out the original idea, rewrote and practically made a new bill of it. At this time not even the sub-committee of the Committee on Agriculture knew of its existence. An official hearing was given, the Atherton bill was adopted as a substitute for the original and favorably reported, but all efforts in the 48th Congress were unsuccessful. Meantime Dr. Cooke, of New Jersey, and Dr. Atherton sent a circular letter to all the institutions in the country likely to be interested in the bill.

PASSAGE OF THE HATCH ACT.

Before the 49th Congress met a convention of agricultural college presidents was held in Washington. They approved the measure and appointed Dr. Atherton, of Pennsylvania, President Willetts, of Michigan, and General Lee, of Mississippi, all presidents of agricultural colleges, a legislative committee to look after the bill.

Soon after the opening of the 49th Congress a hearing was had before the Committee on Agriculture. The chairman, Hon. W. H. Hatch, reported the old bill with very slight changes, and the interest of its friends, ably seconded by the agricultural press, brought the bill to a successful issue. The bill provided that the first payment should be made on October 1st, 1887, but Congress failing to make the appropriation, payments were not made till some three months later. By the provisions of this Act each State accepting the conditions receives the sum of $15,000 annually, so long as the appropriation is made by Congress, for an experimental station.

STATE LEGISLATION.

At this stage let us glance at the legislation in this State supplemental to these Congressional Acts.

The General Assembly of 1863 passed resolutions authorizing the Governor on the part of the State to accept and receive the land-scrip, 120,000 acres, from the United States authorities "upon the terms and conditions of said Act contained and set forth; and that the faith of the State be and is hereby pledged to the United States that upon receipt of the scrip provided to be issued under the said Act of Congress it will faithfully apply the proceeds thereof to the objects and in the manner prescribed by this Act."

STATE AND BROWN UNIVERSITY.

The Governor was also authorized to transfer to Brown University all the land-scrip this State received, that institution agreeing to assume all responsibilities and faithfully discharge all obligations imposed upon and assumed by the State in the Land Grant Act.

Section 6 of the agreement on the part of the University with the State was "To educate scholars each at the rate of $100 per annum to the extent of the entire annual income from said proceeds, subject to the proviso as aforesaid. The Governor and Secretary of State to have the right on or before Commencement day of each year and in connection with the President of the University to nominate candidates for the vacancies occurring in said college or department."

STATE BENEFICIARIES, HOW NOMINATED.

A resolution was also passed constituting the "Senators and Representatives in the General Assembly for the time being a Board of Commissioners whose duty it shall be during the January Session of each year to present to the Governor and Secretary of State the names of worthy young men from the several towns to be educated as State beneficiaries in Brown University, according to the Act of Congress, etc. And the said Commissioners are hereby instructed after one candidate has been presented from each town in the State (the order of the towns

to be determined by lot) to select the candidates as far as may be from the several towns in the ratio of their representation in the House of Representatives, and from that class of persons who otherwise would not have the means of providing themselves with the like benefits; and that the Governor and Secretary of State be and they hereby are instructed to select candidates from the names presented in such manner as that whenever for any reason any town shall not have received its just quota of those admitted to said University, such town shall have in the nomination of subsequent candidates priority over those towns which have received their full quota."

REPORT OF THE BOARD OF EDUCATION.

The Board of Education in 1869, in a report to the General Assembly in relation to the agricultural department of Brown University, "Are of the opinion that the intentions of Congress have not been carried out in good faith by either Rhode Island or Brown University." In order that the evident intentions of Congress may be faithfully carried out the committee offered a resolution, the chief feature of which was the appropriation by the State of $10,000, "for the purpose and maintenance in connection with the agricultural department of Brown University of an experimental garden or small farm, together with such buildings and apparatus as may be necessary," provided a like sum shall be raised by private subscription before October 1, 1869. This resolution never became a law.

COMMITTEE TO INVESTIGATE.

In January, 1872, in the report of the committee appointed in 1871 to investigate the matter of the employment and use by Brown University of the land-scrip given by the United States, the committee state that in 1870 it was brought to the notice of several members of the General Assembly that the income of the land grant fund was likely to be applied to mere classical college education.

Upon investigation the committee find that the University has what it calls in its catalogue an agricultural and scientific department; that it

is evident that this is in accordance with the agreement, but equally evident that no college has been practically established, and that omission is contrary to the spirit and letter of the Act of Congress. The committee recommend that the University be requested to organize the college in question by appointing some capable and able individual who shall be its chief, etc., and "Finally, your committee are convinced that no classical or other instruction may lawfully be imparted at the cost of this foundation, unless the same be conditioned upon the faithful pursuit of the Agricultural and Mechanical Course, etc."

METHODS OF APPOINTING BENEFICIARIES CHANGED.

The law governing the appointment of the beneficiaries was found to be too strict in detail, there being a large number of applicants from the cities and larger towns, so in June, 1873, a more liberal method of appointment was substituted and the old law repealed. The new law provides that the candidates shall be selected in such manner that the people of the several *counties* shall participate in the benefits of the national donation as nearly as may be practicable in proportion to their respective population. Also that the young men "shall not have means of procuring an education for themselves."

In January, 1884, a resolution was passed appropriating $75 instead of $100 per annum for the education of each beneficiary under the Land Grant Act. All this legislation shows a continual feeling on the part of citizens of the State that the spirit of the law, if not the letter, was being broken in the use of the income of this fund, designed especially to foster agricultural and mechanical education. That instead of those branches being the *leading object* without excluding other scientific and classical studies, as required in the Act, classical and scientific studies have been the leading object and agriculture as nearly excluded as possible.

This conclusion is but confirmed by an examination of

THE ANNUAL CATALOGUE OF THE UNIVERSITY,

where the only mention of *required studies* under the State scholarships is *one hour per week*, in the *first half* of *Senior year*, devoted to Agri-

cultural Zoölogy. Under the departments of Practical Science we find Agriculture placed as the sixth, and the course of instruction includes the courses in the preparatory branches—Chemistry and Physics, Physiology, Botany, Zoölogy and Comparative Anatomy—and the one hour per week mentioned above.

The last three branches named are elective, according to the catalogue, and therefore may or may not be taken by the State beneficiary.

NUMBER OF STATE BENEFICIARIES.

According to the records of the proceedings of the Grand Committee of the General Assembly, there have been 240 persons named as beneficiaries, of which number 115 are from Providence, just a trifle less than 48 per cent. of the entire number, Newport 14, Pawtucket 13, and Woonsocket 5, a total for the cities of 147, leaving 93 for the 32 towns in the State. Bristol has sent the largest number, 11, and South Kingstown the next largest, 8, while Jamestown, Charlestown, West Greenwich and Coventry have not been represented at all. The largest number appointed in any one year was 31, in 1887. Seventeen of these were from Providence. All the young men nominated by the General Assembly have not been appointed by the committee, consisting of the Governor, Secretary of State and President of Brown University. Just how many of the 240 have practically received the aid of the fund we are unable to say; we have obtained authentic records only for the past four years.

A young man once appointed usually has the benefit of the scholarship through the course of four years.

TABLE OF GRAND COMMITTEE NOMINATIONS STATE BENEFICIARIES TO BROWN UNIVERSITY.

TOWNS.	1868	1869	1870	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	TOTAL.
Newport	1					3	1	1			2	1		1	2		1			1		14
Providence						12	5	3	4	10	14	4	8	9	11	1	5	9	3	17		115
Portsmouth												1										1
Warwick								1							1		1			2		5
Westerly											1	1	1	1								4
New Shoreham															1							1
North Kingstown							2								1					1		4
East Greenwich												1										1
Jamestown																						
Smithfield	1					1	1	1		1												5
Scituate						1					2				1							4
Glocester												2			1					1		4
Charlestown																						
West Greenwich																						
Coventry																						
Exeter						1																1

Middletown	....	....	....	....	....	1		....	....	....	....	1	1	....	....	....	....	....	....	....	....	3
Bristol	....	....	....	....	....	....		2	....	1	1	2	2	....	....	....	1	....	1	1	....	11
Tiverton	....	....	....	....	....	....		....	....	....	....	1	....	....	....	....	....	....	1	1	....	3
Little Compton	....	....	....	....	....	1		....	....	....	....	....	....	....	....	....	1	....	....	....	....	2
Warren	1	....	....	....	....	....		....	....	....	....	....	....	....	....	1	....	1	....	....	....	3
Cumberland	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	1	1	1	....	....	....	4
Richmond	....	....	....	....	....	....	....	....	....	....	1	1	....	....	....	....	....	....	....	....	....	2
Cranston	1	....	....	....	....	1	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	3
Hopkinton	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Johnston	....	....	....	....	....	1	....	....	....	....	1	....	....	....	....	....	....	....	....	1	....	3
North Providence	....	....	....	....	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	1	....	3
Barrington	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	....	....	....	2
Foster	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	2
Burrillville	....	....	....	....	....	1	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	2
East Providence	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	2	....	3
Pawtucket	....	....	....	....	....	....	....	....	1	1	....	....	1	1	2	2	....	3	1	1	....	13
Woonsocket	....	....	....	....	....	1	....	....	....	....	....	1	1	....	....	....	1	....	....	1	....	5
North Smithfield	....	....	....	....	....	1	1	....	1	....	....	....	....	....	....	....	....	....	....	....	....	3
Lincoln	....	....	....	....	....	1	1	....	....	....	....	1	....	....	2	....	....	....	....	....	....	5
South Kingstown	1	....	....	....	....	....	....	....	1	1	3	....	1	....	....	....	....	....	1	....	....	8
TOTAL	1	....	....	....	....	29	12	8	8	14	26	17	15	12	24	6	11	15	7	31	...	240

TABLE OF BENEFICIARIES APPOINTED TO BROWN UNIVERSITY 1882–1888.

TOWNS.	College Year 1885–86.				1886.	1887.	1888.	
	Seniors.	Juniors.	Sophomores.	Freshmen.	Freshmen.	Freshmen.	Freshmen.	Total.
Newport							1	1
Providence	5	1	6	8	6	5	8	39
Portsmouth								
Warwick				1				1
Westerly								
New Shoreham								
North Kingstown						1		1
East Greenwich								
Jamestown								
Smithfield								
Scituate								
Glocester								
Charlestown								
West Greenwich								
Coventry								
Exeter								
Middletown	1							1
Bristol			1		1			2
Tiverton								
Little Compton			1					1
Warren								
Cumberland	1	1	1	1			1	5
Richmond								
Cranston					1			1
Hopkinton								
Johnston		1						1
North Providence								
Barrington			1					1
Foster								
Burrillville								
East Providence								
Pawtucket	1	1	1		3	1		7
Woonsocket			1				1	2
North Smithfield								
Lincoln								
South Kingstown								
Total	8	4	12	10	11	7	11	63

In the college year of 1885 and 1886, 8 Seniors, 4 Juniors, 12 Sophomores and 10 Freshmen held State scholarships—a total of 34. To the class entering in 1886 there were 11 appointed, in 1887 there were 7, in 1888, 11, a total of 63 young men who entered college in the years 1882 to 1888. Of this number 39, or 62 per cent., were from Providence, Pawtucket 7, Woonsocket 2 and Newport 1. Total from the cities 49, or over 77 per cent. of the whole number.

We have no means of knowing the profession or kind of business

the State beneficiaries have entered on graduating, but are unable to find *one* who has applied himself to agriculture.

A JOINT SPECIAL COMMITTEE

was appointed January 2d, 1887, to "investigate and report what action is necessary and best to be taken by this State that the agricultural interests of the State may derive the greatest benefit in carrying out the provisions of an Act passed by the 49th Congress, entitled an Act to establish agricultural experiment stations," also instructed "to investigate and report what disposition is now made of the income derived from the Land Grant Fund received by this State from the United States."

The Committee held a number of public hearings during the winter of 1887–8 which were well attended by representative farmers from different parts of the State, and in accordance with the popular opinion that to connect an experimental station with Brown University was inadvisable, the committee reported a bill establishing a

STATE AGRICULTURAL SCHOOL

on an independent basis, which was passed March 23, 1888. A resolution had already been passed on March 20th, appointing a Joint Special Committee to select a site.

This Committee, after inspecting locations in several different towns, selected the "Tefft Farm," better known as the

"OLIVER WATSON FARM"

in the town of South Kingstown. The town gave $2,000, by vote, toward the purchase of the farm, citizens and friends contributed $2,000 more, and the State paid $1,000. At the adjourned May Session, June 13th, as provided in the Act establishing a State Agricultural School, His Excellency, Governor Taft, appointed a

BOARD OF MANAGERS

consisting of five members. Mr. J. A. Budlong, the appointee from

Providence county, declining to serve, the present incumbent was appointed July 13, 1888, and on the following day, at the call of His Excellency for a meeting in his office at the State House, members of the Board of Managers and the Joint Special Committee informally discussed the Act creating the school and plans for the Experiment Station. A similar meeting was held a week later. On July 30, 1888, all the members of the Board, excepting one who was out of the State, met at the farm in South Kingstown pursuant to a call issued by the Secretary of State. The Chairman of the Joint Special Committee accompanied the Board on this tour of inspection, and citizens of the town kindly furnished conveyance and entertainment. At this meeting the

BOARD ORGANIZED

by the choice of Charles O. Flagg, of Cumberland, President, and Melville Bull, of Middletown, Secretary and Treasurer.

Section 4 of the Act establishing the school provides that "Any sum which shall be received by the State by virtue of any Act of Congress for the promotion of Agriculture shall be appropriated to the use of said Board for the purpose for which said sum was appropriated."

As the time had already expired in which the first year's appropriation under the Hatch Act could be expended, it reverted to the United States, but steps were immediately taken on the part of His Excellency, Governor Taft, and the Board, to make out and file with the proper authorities at Washington the necessary papers to secure to this State the $15,000 annually paid under the Hatch Act. The $5,000 appropriated in the Act for the establishment of the school by the State, was not available through a technicality, and therefore no decided steps have been taken toward organizing a school. At the meeting on July 30 the Board voted to visit Storr's School, at Mansfield, and the Experiment Station, in Amherst, Mass., hoping to get further information regarding the practical working of those institutions. But two members of the Board were able to go on August 16 and 17. They very much regretted the absence of their co-workers, as the trip was very instructive.

At the call of the President, a meeting was held at the State Fair Grounds September 27, where Hon. Charles H. Peckham, Chairman of the Joint Special Committee, formally announced to the Board the signing and receipt of the deed of the farm, so long delayed by the serious illness and death of Mr. Tefft.

On October 13, the Treasurer received the

FIRST QUARTERLY INSTALLMENT

of the Hatch Fund, $3,750. On the 25th, Dr. Goessman of the Massachusetts Agricultural Experiment Station met the Board by invitation at the farm to inspect and advise with relation to building, laying out experimental plats, etc.

November 3d, a meeting was held at the State House, where it was voted that the funds of the Board be deposited with the Rhode Island Hospital Trust Company. That the Treasurer give bonds satisfactory to the Board for $3,750. (A bond for $4,000, satisfactory to the Board, was filed later with the President and deposited by him with the State Treasurer.) That the President secure a survey and plot of the farm, also photographs of the farm and buildings for future reference. Charles O. Flagg was appointed Director *pro tem.*

Three meetings were held in November and another in December. Mr. E. A. Ellsworth of Holyoke, a civil engineer with some experience in the construction of laboratories, was employed to furnish designs and specifications for a laboratory for the Experiment Station. Rev. Edgar F. Clark, connected the past summer with the United States Geological Survey, has been employed to make a short geological examination of the rocks and soils of the farm, a report of which will be published on the bulletins of the station. The survey of the farm has been entrusted to Charles F. Chase, C. E., and the work is nearly completed.

By vote of the Board the Director *pro tem.* attended the second annual meeting of the American Association of Agricultural Colleges and Experiment Stations at Knoxville, Tenn., January 1-4, 1889. Delegates were present from 31 States, including all east of the Missis-

sippi river, excepting Florida. The work of the experiment stations, methods pursued, and advantages to the public, with many other questions of interest were ably discussed, furnishing much valuable information to station workers.

THE FARM

at South Kingstown is situated on the westerly side of Kingston Hill, about one-half mile from the post office and one and seven-tenths miles from the depot, although the west end of the farm comes quite near to the railroad. It consists of about 140 acres of land, that on the hill being moist, stony land, with impervious subsoil, while the plain is a sandy loam soil, free from stone, with a gravelly subsoil at the depth of three to four feet, and permanent water at sixteen to twenty feet from the surface.

THE BUILDINGS

are a two-story house with old fashioned chimney and ell, size 36¾ feet by 28½ feet—ell 22 feet by 20 feet. The barn was built about seventeen years ago and is 36½ feet by 32½ feet on the ground. There are some other small buildings, wagon-sheds, corn-house, poultry house, etc. On the plain is a barn that was in very poor repair, one end being entirely out. It was originally 20x30 feet, with 12-foot posts. This has been raised a little, new-silled and ten feet in length added to the open end. Several cords of good fertilizing material was taken out of the old floorway and stables. With a new roof, new doors, etc., it makes a good barn for storing hay, all the space being utilized for that purpose.

FARM WORK.

Mr. H. F. Adams has been employed as working foreman, lives in the house and boards the farm help at present engaged in clearing brush from a portion of the pastures. The rail fences which subdivided the plain land have been taken down, making one large field of three smaller ones. Seven and one-half acres of land have been plowed

at the west end of the plain, being a part of the old sheep-pasture and badly overgrown with moss. Quite a quantity of rocks have been taken out of the field just northeast of the barn. The avenue has been cleared from brush and the grade stakes set out for constructing a drive way. It is proposed to remove the surface soil for fifteen feet in width and use the small stone of the cross walls in making a road-bed, and with proper attention to drainage we hope to have a dry, firm driveway.

A good pair of horses six years old and weighing 2,600 lbs. have been purchased, also a cow. Some farming tools and wagons have been provided, and others will be bought later.

WANTS OF THE EXPERIMENT STATION.

To fully equip the Experiment Station requires the construction of a laboratory and barn, plans for the former of which are now completed. The design calls for a stone building constructed from the material on the farm, the main building $45\frac{5}{6}$x$19\frac{1}{6}$ feet and two stories high, with two wings each $32\frac{1}{3}$x$19\frac{1}{6}$ feet and one story high, with basement under the whole. The main building will be used for office, collection rooms, etc. The wings are provided with flues, retorts, etc.. for chemical work. To construct this building in a substantial manner will require nearly if not quite $10,000. Designs for a barn are not yet made.

By the condition of the Hatch Act, $3,000 of the first annual appropriation paid to any State by the United States may be used for building purposes, and this sum the Board deem sufficient to build the necessary additions to the existing barn and repair the sheds, etc., including the work already done to the barn on the plain.

Therefore to place the Experiment Station on a substantial basis the Board of Managers would respectfully ask the General Assembly to appropriate the sum of $10,000 with which to construct a laboratory and otherwise provide for the efficient conduct of the Rhode Island State Agricultural Experiment Station. Once established it is expected the annual grant from Congress will provide for the wants of the Station.

THE STATE AGRICULTURAL SCHOOL

to be organized when the appropriation made for the purpose becomes available will require for its development a school building to accommodate from thirty to fifty students with facilities for boarding, laundry, etc., also recitation rooms and reading rooms.

This building will certainly be needed by another year. It is also hoped that the State or friends of the institution will provide the facilities for

INDUSTRIAL TRAINING

in the mechanic arts, which would require an appropriate building, boiler, engine and machinery. A knowledge of wood and iron working is valuable to the farmer, enabling him oftentimes to save both time and money, and such a department would afford valuable training during the winter months when manual work on the farm is difficult to provide.

Finally, the Board would respectfully urge that in their opinion the agricultural and mechanical interests of the State will best be promoted by appropriating the income from the Fund obtained from the sale of the Agricultural College Land Scrip to the Rhode Island State Agricultural School, believing that the University having over sixty scholarships of $1,000 each and upward endowed by private benefactors is in no sense dependent upon the income from the Land Grant Fund for any measure of its prosperity, while to the infant Agricultural School it will prove of great assistance.

To this end the Board would recommend that your Honorable Body take such action as shall prevent any further appointment of State beneficiaries to Brown University, and shall, as soon as those now receiving the aid of the income from the fund have graduated or ceased to attend college, cause the Land Grant Fund to be an endowment for the Rhode Island State Agricultural School and the income thereon available for its support. That there is a

DEMAND FOR SUCH A SCHOOL

is shown by the fact that last September, nearly *twice* as many young men applied for admission to Storr's School at Mansfield, Conn., as could be accommodated.

There is also a demand for men as teachers and investigators in special lines related to agriculture—such men as these schools and agricultural colleges educate.

The recent statement of the chemist of the Bureau of Agriculture that in the event of the manufacture of sorghum sugar becoming commercially practicable, more people will be immediately needed for the scientific work connected therewith than the whole number who are now competent and available is evidence that the field of the natural sciences is not over crowded with workers.

This day is perhaps not far distant, for the average per cent. of sugar in beets in the early history of the beet sugar industry was about six per cent. and by judicious selection of seed grown from beets known to contain a higher per cent. of sugar the average per cent. has been raised to a very profitable point. The prospect is encouraging that these same facts may be realized in the case of sorghum industry.

The Board are unanimously of the opinion that the hearty support of the State in organizing and equipping the Rhode Island Agricultural School will be appreciated by the citizens of the State, result in great good to the agricultural and mechanical industries of the State and thus to the benefit of all.

Respectfully submitted,

CHAS. O. FLAGG,
CHAS. J. GREENE,
MELVILLE BULL,
C. A. SHIPPEE,
CHANDLER H. COGGESHALL.

State of Rhode Island and Providence Plantations.

SECOND ANNUAL REPORT

OF THE

BOARD OF MANAGERS

OF THE

Rhode Island State Agricultural School and Experiment Station,

MADE TO THE

GENERAL ASSEMBLY AT ITS JANUARY SESSION, 1890.

PART II.

Rhode Island.

STATE AGRICULTURAL EXPERIMENT STATION,

[Part I—State Agricultural School—is printed under separate cover.]

PROVIDENCE:
E. L. FREEMAN & SON, PRINTERS TO THE STATE.
1890.

BOARD OF MANAGERS.

Rhode Island State Agricultural School and Experiment Station.

C. H. Coggeshall,	Bristol County.
Chas. O. Flagg,	Providence County.
Chas. J. Greene,	Washington County.
Melville Bull,	Newport County.
C. A. Shippee, of W.,	Kent County.

OFFICERS OF THE BOARD.

Chas. O. Flagg, President, . . . P. O., Kingston, R. I.
Melville Bull, Secretary and Treasurer, P. O., Newport, R. I.

STATION STAFF.

Chas. O. Flagg,	Director.
L. F. Kinney,	Horticulturist.
H. J. Wheeler,	Chemist.
Samuel Cushman,	Apiarist.
H. F. Adams,	Farmer.

The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office, Kingston, Rhode Island.

REPORT.

To His Excellency, H. W. Ladd, Governor, and the Honorable, the General Assembly of the State of Rhode Island, at its January Session, 1890:

KINGSTON, Jan. 31st.

The Board of Managers of the Rhode Island State Agricultural School and Experiment Station present their Second Annual Report in two parts, the first relating to the State Agricultural School and the second to the State Agricultural Experiment Station. The reason for so doing may be found in Part First, to which the reader is referred.

This report includes the five bulletins issued during the year, the reports of the Director, Horticulturist, Chemist and Apiarist for the year ending December 31st, 1889, the financial statement of the Treasurer for the year ending June 30, 1889, to which is appended a general list of the stock, teams, tools, scientific instruments and apparatus, bees, hives, trees, plants, etc., purchased for the use and work of the Station.

Early in the year Mr. L. F. Kinney, B. S., Assistant at the Hatch Experiment Station, Amherst, Mass., was engaged to take charge of the horticultural work of the Station and commenced his duties at the Farm March 1st. During this month a meteorological outfit was purchased, a slat building prepared for the thermometer and

barometer and on April 1st a record commenced of observations taken thrice daily, which it is proposed to continue indefinitely. A summary of the records forms a part of bulletin No. 5. Prof. Kinney has taken most of the observations, superintended the planting and care of the nursery and vegetable garden and faithfully executed the details of the potato experiment, which forms the subject of bulletin No. 5.

The Board also engaged Mr. H. J. Wheeler, then pursuing special studies in Chemistry and Geology at Göttingen, Germany, as Station Chemist, his duties to begin at the Farm September 1st. Meanwhile, two thousand dollars was placed at his disposal with instructions to purchase in Europe the apparatus and outfit necessary for work in his division. This was done as a matter of economy, it being possible to lawfully import them for the use of the institution duty free, and hence quite a saving resulted.

Dr. Wheeler, with five years post graduate practical experience in the laboratory of the Massachusetts Agricultural Experiment Station and the opportunities afforded by his two years' study in Germany to become familiar with the work of the best European investigators, is able to bring to his work much valuable information, which we trust will eventually be of benefit to the State.

Early in the spring the Board appropriated the sum of five hundred dollars for the purpose of establishing an apiary and collection of specimen hives and bee supplies. While the natural conditions in this State are such that *wholesale honey* production may never be profitable, it is believed that the keeping of a *few* colonies of bees may be profitable to *many* farmers, and incidentally result in profit to the agriculturist through the better fertilization of fruit and berry blossoms. The thorough, practical experience in his own apiaries, joined to an enthusiastic interest in his work and some little reputation as a writer upon the subject of bee-keeping, led the Board of Managers to place this division in charge of Mr.

Samuel Cushman, of Pawtucket, and the work during the season has been of much interest to many. Mr. H. F. Adams, as farmer, has faithfully discharged his duties in a manner satisfactory to the Board of Managers.

The work of the year has been in a great measure preparatory and in the line of permanent improvements. The farm, as purchased, contained about one and seven-eighths miles of interior stone walls, and was approached over a cart-path, which in spring and during rainy weather was very muddy. The first work after cutting several acres of brush in the pastures was to lay out a graded road-way, fifteen feet in width, along the avenue and across the pasture to and around the farm-house. The earth was thrown out sufficiently deep to allow of filling in stone to average one foot in depth, crowned six inches at the center, finely broken on the top and covered six inches deep with the sub-soil. Over one mile of the interior walls have been thus used with the exception of a few large foundation stone, which will be otherwise disposed of. Allowing a stone wall to cover five feet in width, over half an acre of good land has been uncovered, and at the same time a good road-way constructed. During the summer the Town Council of South Kingstown laid out a highway, commencing near the bridge over the Chipuxet river on the highway leading to the railroad station and extending north-easterly across the plain to the Exeter line. The highway crosses the station farm in a diagonal direction, near the depression in the plain, and runs toward the east along the north boundary line 1,355 feet, then turns toward the north and off the farm. As soon as time and means will permit, the road-way already built to the farm-house will be continued toward the west to meet the new highway, thus shortening the distance from the farm-house to the railroad station 1,584 feet, or 96 rods.

During the January Session of 1889 the General Assembly

appropriated the sum of $10,000 for the purpose of building a Chemical Laboratory on the Farm in accordance with plans then adopted, but upon receiving bids for construction from several responsible parties it was found that the appropriation was insufficient and an additional appropriation of $4,000 was asked and granted at the May Session. As soon thereafter as possible the contract for constructing the building was let to Mr. William Gosling of Newport. Mr. William Weeden, having the contract for excavating the cellar, began work June 4th. On August 8th a *corner-stone* was laid at the north west corner of the building, with a brief ceremony and in the presence of the Board of Managers and about fifty people who had gathered from the vicinity. The assembly was called to order by the President of the Board, who invited Rev. E. F. Watson, of Matunuck, to offer prayer. The laying of the corner-stone followed. In a pocket made for the purpose, under the corner-stone, was placed a carefully sealed glass jar in which had been placed a copy of the Report of the Joint Special Committee appointed by the General Assembly to purchase a site for the State Agricultural School; a copy of the First Annual Report of the Board of Managers to the General Assembly; a copy of the Rhode Island Manual for 1888-9; a roll of the Rhode Island House of Representatives, May session, 1889; a roll of the Rhode Island Senate, special session, July, 1889; a list of the town officers of the Town of South Kingstown; a list of the Experiment Station working staff; name of the architect, E. A. Ellsworth, Holyoke, Mass.; name of the builder and others engaged in the work; a copy of the *Providence Journal* for July 14, '89, containing an illustrative article descriptive of the station and farm, and five pennies of this year's coinage. Mr. J. G. Peckham, of Kingston, in a few words, characterized the occasion as an auspicious one for the farmers of the State and of the South County in particular. The sympathy of the community in the work and

prosperity of the institution was expressed by Rev. Mr. Clark, pastor of the Kingston Church, who closed the brief and impromptu ceremony with prayer and benediction.

From the Congressional appropriation the Board of Managers have been able to use this year $3,000 for building purposes. Of this sum $177.72 was used in enlarging and repairing the old barn on the plain and $133.08 in the construction of the "Bee-house." The balance, $2,689.20 has been used in the construction of stables and sheds for the teams and tools.

Just twelve feet from the south-west corner of the farm barn, and extending toward the south, has been built a structure 20×48 feet, with 14 foot posts. This gives two high, open sheds for loads of hay or grain, and at the south end a room 20×20 feet, provided with a chimney, for use as a work-shop, over which is a pleasant room with bay-window for a farmer's office and seed room. Extending east and west across the north side of the barn the new stable has been built; this is 118×20 feet. At the west end is a manure shed 20×20 feet, with concrete bottom, about 4½ feet below the stable floor and easy of access through doors on a level with the surface at the west end. The stable is concreted throughout, and stalls are provided for eight horses and seven cattle, besides two good box-stalls. On a line with the east end of the stable a shed 80×20 feet extends toward the south, and that end is finished to correspond with the south end of the first mentioned shed, and the room 20×20 can be used for a work-shop, occasional slaughtering of beef or pork, etc., with a small office up stairs. A chimney is provided so that the rooms can be heated. A low shed 23×20 feet is next the slaughter room, with loft for storage purposes, then a high shed 14×20 feet and a tool-room 23×20 feet, with loft over it, take up the entire space. These are all built of wood, shingled and stand on good stone foundations, well drained. A feed-room, under which is a cistern for water supply, and a

harness-room will occupy a part of the space in the old barn and the balance will be used for tools and light wagons, and the entire upper part for the storage of hay. These sheds make ample provisions for our *teams* and *tools*, but a stock barn to accommodate a select herd of cows for experimental feeding and to convert the products of the farm into milk and butter for the use of the school is one need of the near future. A second is a suitable greenhouse and work-rooms for the Horticultural Division, to which allusion is made in another part of this report. For various reasons the publications of the station have not been issued as promptly as désirable, a failing we trust a further division of labor will entirely obviate in the future.

The Board have held fourteen meetings during the year, ten of which have been at the Farm, and the other four at the State House in Providence. While the many difficulties incident to the organization of a new work in a new locality have been consecutively arising, and the exceptionally rainy season has caused corresponding interruptions and delays in the accomplishment of the work in hand, the Board feel that the progress of the year is encouraging, and look to the coming year for results of more decided benefit to the agricultural interests of the State.

Respectfully submitted by the Board of Managers,

CHARLES O. FLAGG, *President.*

ORGANIZATION.

BULLETIN No. 1.

CHARLES O. FLAGG.

KINGSTON, March, 1889.

The object of this first Bulletin is to give information regarding the creation and organization of this institution.

National aid for agricultural and mechanical education dates from the passage by Congress of the "Agricultural Land Grant Act," signed by President Lincoln, July 2, 1862.

Hon. Justin S. Morrill, National Representative from Vermont, was the author of the bill, having labored persistently for nearly five years for its passage in one form or another, and once succeeding, only to have the bill vetoed by President Buchanan. The General Assembly of this State in 1863 passed resolutions authorizing the Governor on behalf of the State to accept and receive the landscript (120,000 acres—30,000 acres for each United States Senator or Representative), and transfer the same to Brown University, that institution agreeing to assume all responsibilities and faithfully discharge all obligations imposed upon and assumed by the State in the Land Grant Act. Section 6 of the agreement on the part of the University with the State was "to educate scholars each at the rate of $100 per annum (reduced to $75 per annum at the January session, 1884), to the extent of the entire annual income from said proceeds, subject to the proviso as aforesaid—the Governor and Secretary of State to have the right, on or before

Commencement Day of each year and in connection with the President of the University, to nominate candidates for the vacancies occurring in said college or department."

The landscript was located in Kansas, a "Border State" at that time and subject to all the social, political and lawless phases of life and society which have characterized for a longer or shorter time many of our frontier States.

As the land became subject to tax as soon as located and Brown University had no fund from which to defray such expenses and therefore could not carry it over the period of depression following the war, it was disposed of to a syndicate which bought up some of the land grants of other States as well as this—the 120,000 acres realizing a fund of $50,000 for the University. The income of this fund has been regularly expended in State scholarships, with the exception of a few years about 1869—1872, when no candidates were appointed by the State, and the interest accumulated. The income of this fund has assisted many deserving young men to an education, but not an agricultural or mechanical education. The *one hour per week* in the *first half of Senior year* devoted to agricultural zoölogy, the only agricultural work specially required of State beneficiaries, is simply tolerated by the students for the sake of securing the scholarships, and the young men have gone out into various professions, but not one has followed agriculture. These young men are mostly residents of our cities. Of the sixty-three State beneficiaries at Brown University from 1882 to 1888, thirty-nine, or 62 per cent., were residents of Providence, and forty-nine, or 77 per cent., of the whole number, from the four cities of the State.

More or less dissatisfaction has been expressed at various times with the manner of using the Land Grant Fund. In 1869 the State Board of Education, in a report to the General Assembly in relation to the agricultural department of Brown University, "are of the opinion that the intentions of Congress have not been carried out in good faith by either Rhode Island or Brown University," and offer a resolution making a State appropriation of $10,000, provided a like sum is raised by private subscriptions before Oct. 1st, 1869, for the purpose of maintaining, in connection with the agricultural department of Brown University, an experimental gar-

den or small farm, together with such buildings and apparatus as may be necessary. The resolution was not adopted. In January, 1870, it was brought to the notice of several members of the General Assembly that the income of the Land Grant Fund was likely to be applied to mere classical education. A committee to investigate was appointed in 1871, and in 1872 report that the committee find the University has what it calls in its catalogue an agricultural and scientific department, that it is evident that this is in accordance with the agreement, but equally evident that no college has been practically established, and that omission is contrary to the spirit and letter of the Act of Congress. The committee recommend that the University be requested to organize the college in question by appointing some capable and able individual who shall be its chief, etc., and "Finally, your committee are convinced that no classical or other instruction may lawfully be imparted at the cost of this foundation, unless the same be conditioned upon the faithful pursuit of the agricultural and mechanical course, etc." This led to the appointment of a Professor in the department of Agricultural Zoölogy and to the required studies mentioned above, viz., one hour per week in the first half of Senior year. Such, in brief, are the facts relating to the Land Grant Fund and its work in this State.

The occasional manifest dissatisfaction on the part of some grew into a settled conviction with the thinking agriculturists of the State that the income of the fund designed by Congress to foster and aid agricultural and mechanical education, although doing a good work in its way, was being totally misapplied according to the *spirit* and *intent* of the Land Grant Act. The central idea of the Act of 1862 was to foster *teaching*, and in that teaching to make especially prominent agricultural and mechanical studies and training—to provide what we did not possess, an institution where any young man could pursue the study of agriculture, not excluding such other studies as are necessary in any liberal course of education. In several of the agricultural colleges original work in the line of experiments with crops and fertilizers, and investigations relative to the various unsolved problems of agriculture, was a departure from the line of pure teaching provided for in the Act of 1862. To provide the means and encourage work in this

new and broad field of *scientific investigation* a supplementary bill to that of 1862, for the purpose of establishing Agricultural Experiment Stations, was introduced in the Forty-seventh Congress by Hon. C. C. Carpenter, of Iowa. The same bill was introduced in the Forty-eighth Congress by Hon. A. J. Holmes, also of Iowa, but little attention was paid to it in either Congress. At this juncture Dr. G. W. Atherton practically rewrote the bill, and it was introduced in the Forty-ninth Congress as a substitute for the other. Its value was ably advocated by scientific men, and the Congressional Committee on Agriculture labored for its passage. W. H. Hatch was chairman of that Committee, and thus the bill became known as the "Hatch Act."

Following is the full text of the bill approved March 2, 1887:

AN ACT

To establish agricultural experiment stations in connection with the colleges established in the several states under the provisions of an act approved July 2, 1862, and of the acts supplementary thereto.

SECTION 1. *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled:* That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural science, there shall be established, under direction of the college or colleges or agricultural department of colleges in each State or Territory established, or which may hereafter be established, in accordance with the provisions of an act approved July 2, 1862, entitled, "An act donating public lands to the several States and Territories, which may provide colleges for the benefit of agriculture and the mechanic arts," or any of the supplements to said act, a department to be known and designated as an "agricultural experiment station": *Provided*, That in any State or Territory in which two such colleges have been or may be so established, the appropriation hereinafter made to such State or Territory shall be equally divided between such colleges, unless the legislature of such State or Territory shall otherwise direct.

SEC. 2. That it shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and waters; the chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of

different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States or Territories.

SEC. 3. That in order to secure, as far as practicable, uniformity of methods and results in the work of said stations, it shall be the duty of the United States Commissioner of Agriculture to furnish forms, as far as practicable, for the tabulation of results of investigations or experiments; to indicate, from time to time, such lines of inquiry as to him shall seem most important; and, in general, to furnish such advice and assistance as will best promote the purposes of this act. It shall be the duty of each of said stations, annually, on or before the first day of February, to make to the Governor of the State or Territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the said Commissioner of Agriculture, and to the Secretary of the Treasury of the United States.

SEC. 4. That bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same, and as far as the means of the station will permit. Such bulletins or reports and the annual reports of said stations shall be transmitted in the mails of the United States free of charge for postage, under such regulations as the Postmaster General may from time to time prescribe.

SEC. 5. That for the purpose of paying the necessary expenses of conducting investigations and experiments and printing and distributing the results as hereinbefore prescribed, the sum of $15,000 per annum is hereby appropriated to each State, to be specially provided for by Congress in the appropriations from year to year, and to each Territory entitled under the provisions of section eight of this act, out of any money in the Treasury proceeding from the sales of public lands, to be paid in equal quarterly payments, on the first day of January, April, July, and October in each year, to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the 1st day of October, 1887. *Provided, however*, That out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement or repair of a building or buildings necessary for carrying on the work of such station; and thereafter an amount not exceeding five per centum of such annual appropriation may be so expended.

SEC. 6. That whenever it shall appear to the Secretary of the Treasury from the annual statement of receipts and expenditures of any of said stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station, in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support.

SEC. 7. That nothing in this act shall be construed to impair or modify the legal relation existing between any of said colleges and the government of the States or Territories in which they are respectively located.

SEC. 8. That in States having colleges entitled under this section to the benefits of this act and having also agricultural experiment stations established by law separate from said colleges, such states shall be authorized to apply such benefits to experiments at stations so established by such States; and in case any State shall have established, under the provisions of said act of July 2d aforesaid, an agricultural department or experiment station, in connection with any university, college, or institution not distinctively an agricultural college or school, and such State shall have established or shall hereafter establish a separate agricultural college or school, which shall have connected therewith an experimental farm or station, the legislature of such State may apply in whole or in part the appropriation by this act made, to such separate agricultural college or school, and no legislature shall by contract express or implied disable itself from so doing.

SEC. 9. That the grants of money authorized by this act are made subject to the legislative assent of the several States and Territories to the purposes of said grants: *Provided*, That payments of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of its legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof duly certified to the Secretary of the Treasury.

SEC. 10. Nothing in this act shall be held or construed as binding the United states to continue any payments from the Treasury to any or all the States or institutions mentioned in this act, but Congress may at any time amend, suspend or repeal any or all the provisions of this act.

A ruling of the United States Treasury Department, that the passage of the act only fixed the amount to be expended in each State and made no appropriation therefor, made necessary an act passed February, 1888, specially appropriating to each State for use before July 1st, 1888, the sum of $15,000 "out of any money in the treasury not otherwise expended." The Rhode Island General Assembly on January 2, 1887, appointed a Joint Special Committee to "investigate and report what action is necessary and best to be taken by this State that the agricultural interests of the State may derive the greatest benefit in carrying out the provisions of an act passed by the Forty-ninth Congress entitled 'An act to establish agricultural experiment stations;'" also instructed to "investigate and report what disposition is now made of the income derived from the Land Grant Fund received by this State from the United States." The committee held several public hearings during the winter of 1887–8, which were well attended by

farmers from different parts of the State. The fact was emphasized that three courses of action were open to the legislators of our State—

1st. Should the General Assembly take no action whatever the State would not participate in the benefits of the "Hatch Act."

2d. Should the General Assembly accept the conditions of the "Hatch Act" and take no *further action thereon*, Brown University would receive annually the $15,000 to be expended for the purpose named in the act, by virtue of possession of the Land Grant Fund of 1862, to which the "Hatch Act" is supplemental.

3d. To take advantage of the opportunity afforded by a clause of the 8th section of the "Hatch Act" "to establish a separate agricultural college or school which shall have connected therewith an experimental farm or station, the legislature of such State may apply in whole or in part the appropriation by this act made to such separate agricultural college or school."

After several public hearings and in accordance with the sentiment of the agriculturists of the State, the committee reported a bill establishing a State Agricultural School on an independent basis, which was passed March 23d, 1888. Already on March 20 a Joint Special Committee had been appointed to select a site. We quote from their report to the General Assembly, January session, 1889—Hon. Chas. H. Peckham, chairman:

"Your committee desired to select the site for the proposed school and experiment station in the most accessible locality. They hoped to find a farm that should embrace as many varieties and qualities of soil as possible, that upland and lowland and rock and bog could be experimented upon, and that the farmers in Rhode Island should have an opportunity to learn in the school and from it what could be done to the best advantage on Rhode Island soil.

"Many offers were made for the sale of lands to the committee, and visits were made to the several localities from which the offers came; and your committee visited South Kingstown twice, Portsmouth, Cranston, Coventry and Scituate, and found many advantages and good land in all these places.

"In some instances towns offered sums of money toward the purchase of land provided the committee would accept of the tender of land within their limits.

"The town of South Kingstown voted to expend two thousand dollars toward the purchase of a farm, and citizens in the vicinity of the Court House in Kingston offered two thousand dollars additional toward the purchase of a farm the committee had visited, and known as the 'Oliver Watson' farm.

"After much deliberation your committee decided to locate the station on the 'Oliver Watson' farm and entered into negotiations for its purchase for $5,000. . . . The farm was purchased and has been turned over to the Board, into whose custody the General Assembly directed their committee to deliver it."

The appropriation made by the State not being available through a technicality, His Excellency Governor Taft, to prevent further delay, loaned from his private means the $1,000 necessary to complete the purchase.

The deeds were signed and the farm passed into the custody of the State in September, 1888.

The Board of Managers was appointed at the May session under the act establishing the school. It was constituted as published on the second page of this report, with one exception. Hon. J. A. Budlong of Cranston was appointed member from Providence County, but declining to serve, the present incumbent was appointed July 13, 1888, and after two preliminary meetings the Board organized by the election of officers on July 30th, 1888.

According to the conditions of the sixth section of the "Hatch Act" the $15,000 appropriated for this State for the fiscal year ending July 1st, 1888, reverted to the United States, because our organization was not completed in time to secure and use it. This fact we regret, as every other State secured the first year's appropriation, and it could be made exceedingly valuable invested in a library, scientific instruments, stock, tools and fittings. The necessary papers were filed at Washington by His Excellency the Governor and the Board of Managers in time to secure the first installment in October, 1888, of the second year's appropriation.

November 3d the Board appointed a Director *pro tem.*, and work of a preparatory nature commenced.

The work of the Station is outlined in a general way in the second section of the "Hatch Act."

Original investigations are to be made or experiments verified—

1. On the physiology of plants and animals.

2. The diseases to which they are severally subject, and the remedies for the same.

3. The chemical composition of useful plants in their different stages of growth.

4. The comparative advantages of rotative cropping as pursued under a varying series of crops.

5. The capacity of new plants for acclimation.

6. The analysis of soils and waters.

7. The chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of different kinds.

8. The adaptation and value of grasses and forage plants.

9. The composition and digestibility of the different kinds of food for domestic animals.

10. The scientific and economic questions involved in the production of butter and cheese.

11. Such other researches or experiments bearing directly upon the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States and Territories.

The questions enumerated are full of interest, and many a successful practical farmer in the State can propound some question relative to one or more of these subjects that the combined experiment stations in the country cannot yet answer, but many valuable truths have already been made public, and many more are being worked out by persistent and repeated experiments.

In this we hope soon to be able to do our part—first, in investi-

gating such questions as may have a particular bearing upon Rhode Island agriculture; and, second, upon agriculture in general.

Every citizen has an interest here, especially such as are engaged in agricultural pursuits, and we trust will give the Station his aid and sympathy. Quarterly bulletins will be published and mailed free to all the newspapers in the State and "to such individuals actually engaged in farming as may request the same."

A considerable part of the subject-matter of this bulletin has been quoted from the First Annual Report of the Board of Managers—first, because pertinent to the subject of organization, and, second, because there has been a demand for more reports than we have been able to supply.

A larger edition of this bulletin will be printed that there may be enough to supply all demands.

THE FARM.—HISTORICAL DESCRIPTION.

BULLETIN No. 2.

CHARLES O. FLAGG.

KINGSTON, June, 1889.

In view of the fact that this farm, commonly known as the "Oliver Watson" farm, was purchased by a committee duly authorized by the General Assembly—is now the property of the State and the home of the State Agricultural School and Experiment Station, a few facts relating to its history may be interesting at present and perhaps valuable in the future. The earliest acquaintance of the English with these shores found this immediate section quite thickly peopled with members of the Narragansett tribe of Indians. This tribe was numerous and powerful as compared with other tribes of aborigines, and noted for their intelligence and skill in the rude arts of the times, their industry and agriculture. In 1606 nominal English possession was given under a patent granted by King James I, to a company established at Plymouth, in the west of England. Later we find the company composed of Lords, chief of whom was Robert, Earl of Warwick. From that date to March 17th, 1643–4, various patents were granted without much knowledge of, or regard to, the geography of the country. At that time Roger Williams procured from the Earl of Warwick and his associates a patent for Rhode Island, Providence Plantations and Narragansett. Jan. 20, 1657, five men, Samuel Wilbor, John Hull, John Porter, Samuel Wilson and

Thos. Mumford, made their first Pettiquamscut purchase of three chief Sachems of Narragansett—Quassaquanch, Kachanaquant and Quequaquennet. "Jan. 29, 1657, Kachanaquant having agreed to convey to the same men another tract, confirms the former sale and conveys a tract bounded as followeth: 'beginning two miles from Pettiquamscut Rock (a corner bound of the former purchase) north and runneth to the head of the great river 40 rood, and goeth northerly from the Pettiquamscut Rock and turneth northwest, and from said head goes north and northwest by a river called Monassachuet ten miles, and from that bound turns and runs west by south ten miles, or twelve miles on a square and what it wants north to be made up, &c.,'" for £135, dated June 24, 1660. Appended to this deed is a confirmation made several years after by three sons of Kachanaquant.* Deeds of several other tracts of land were obtained from various Sachems, and in 1679 two other persons—Wm. Brenton and Benedict Arnold, were admitted to ownership with the original company. In a record of a "meeting of the proprietors of the lands of Pettyquamscutt the 8th day of April, 1692, it was agreed that for each division there should be seven papers, numbered, rold up, put into a hat, shook, and a youth to give a lott to and in behalf of each proprietor, and each to have that lott in the several divisions as agrees with the number in their lot given them." A record is made of several sections so divided, also the following: "Whereas, there was a thousand acres or more laid out that was to be divided into six shares, and by the proprietors and their order was lotted for about a year since (*i. e.*, April, 1691,) in which tract No. 1 fell to Thos. Mumford, No. 2 to said Capt. Sewall, No. 3 to the right of said Wilbour, No. 4 to the right of said Wilson, No. 5 to said Brenton, No. 6 to the right of said Porter; all which several tracts of land we the proprietors own to be lotted for fairly, according to agreement, and to each of our satisfaction, &c." Hon. Elisha R. Potter, Jr., in his Early History of Narragansett, says: "In the tract of 1,000 acres which the purchasers ordered to be surveyed for themselves, * * * Lot No. 3, of about 200 acres, was laid out to Wilbor, bounded S. and E. by roads, W. by Chepuxet and N. by lot

* Collections of the Rhode Island Historical Society, Vol. III, page 275. To this work, and the records in the office of the Town Clerk of South Kingstown, we are indebted for the facts here stated.

No. 4. (S. K. Rec. 6–44.) * * * Lot No. 4, of about 250 acres, was laid out to Wilson, was afterward owned by Hannahs, Niles, Rowland Brown, &c." This *lot No. 4* included the present Experiment Station Farm. The site of the present village of Kingston —"Little Rest Hill" was probably the next settlement after that of "Tower Hill." Samuel Wilson, one of the five original purchasers, and to whose right lot No. 4 was laid out, married a Teft and died about 1682, leaving three sons and two daughters. This farm became the property of the third child, the eldest daughter, Mary, born in 1663. She married Robert Hannah and their two children were named for their parents, Robert and Mary. After the death of her husband she married George Webb in 1703. In the family of Nathaniel Niles, Sr., were the second child, a son named Nathaniel, and his sister Catherine the next younger child. This brother and sister married respectively the sister and brother, only children of Mary (Wilson) Hannah. Robert Hannah, Sr., at his death left the farm to his widow during her lifetime, then to be the property of his son. In the year 1712 Robert Hannah, (Jr.), "In consideration of the love, good will and affection which I have and do bear towards my honored father-in-law, Mr. George Webb, * * * have given and granted * * * during his natural life, all and singular the housing and land which belongeth to me after my honored father's decease, which said housing and land was given to my mother during her natural life, &c.," conveys a lease of the property to Mr. Geo. Webb during his life with the following provisions: "There shall be no wood, nor hay, nor grass sold off the land, nor any carried upon any account of from the land, and furthermore if my said Father Webb does not see cause to manage the said land and is willing to put it out of his hands, then the said Robert Hannah shall have the refusal of the said land, giving as much as another during the above said time." (S. K. Rec., bk. 2, p. 233.) In 1725 a suit of ejectment was brought by one Jeremiah Wilson against Geo. Webb, and a deed of all right and title to the premises was given by the latter and wife to Robert Hannah. The next transfer is dated Aug. 14, 1728, when Robert and Catherine Hannah sell 100 acres of the farm bounded westerly on the Chipuxet to Benjamin Sheffield, and a few months after (March 21, 1729), the balance of the farm is

sold to Nathaniel Niles, his brother-in-law. Six days after purchasing, Benjamin Sheffield sells 50 acres of his land to Andrew Pitcher. And the latter on April 1st, 1729, sells the same to Nathaniel Niles; and on Aug. 8, 1731, Mr. Niles gains possession of the entire farm by purchasing the last 50 acres of Benj. Sheffield. About this time mortgages were placed on portions of the property in favor of a Board of Trustees empowered by the General Assembly of the Colony, at its May session, 1728, "for the letting out of forty thousand pounds in bills of Publick Credit on sd. Colony." Nathaniel and Mary Niles made the farm their home through life, and reared a family of six sons and five daughters. During these years slaves were lawful property in the Colony, and that there was quite a family of servants belonging to the Niles family is indicated by the will of Nathaniel Niles, duly recorded at the office of the town clerk. Mary Niles died in 1765 and her husband a year later, at the age of 89. In his will he makes Silas Niles executor, and gives, "To son Paul the N. half of the farm on which I live and easterly part of the house with cheese-house, and improvement of negroes 'Andrew' and 'Cæsar,' and one half the farming tools. To son Silas the westerly part of the house, southerly part of the farm and small dwelling house on it; the negroes 'Cuff,' 'Jabez' and 'Peter,' one half the farming tools, &c. * * To son Jeremiah a case for clothes and books, he having had already. To daughter Sarah, negro woman 'Zippora.' To Daughter Hannah Rodman negro 'Abigail.' To Daughter Katherine Gardner negro 'Prue.' To wife Mary, a negro woman, bed and 1-6 of the movables. To five daughters each 1-6 of the movables. To grand children—children of Abraham Perkins—one negro girl 'Rose.'" Son Nathan has already had a farm at Groton and 500 acres in this town, and therefore received no bequest in the will. On Feb. 7, 1775, Paul Niles and Lucy Anne, his wife, sell to Silas Niles (probably Silas, Jr.,) their portion of the farm, 190 acres, for 900 pounds. Feb. 3, 1783, Hannah Niles, widow of Silas Niles, (Sr.,) deeds all the right and title she has to 160 acres for rent charges or annuity of thirty-six pounds five shillings, to Silas Niles, (Jr.,) of Norwich, County of New London, Conn. Four days later, Feb. 7, 1783, Silas Niles and Esther, his wife, for 1440 pounds lawful silver money, deed to Rowland Brown about 300 acres, ex-

cepting only one-fourth of an acre where the burying place is; and the farm passes out of the possession of the Niles family, by whom it was owned fifty-four years. As Rowland Brown was a large land holder, owning a fine farm in another portion of the town, which was called his homestead, it is highly probable that he never resided here, but let the property to others. James Knowles was living here in 1791, and Jeremiah Carpenter occupied the farm nineteen years, from 1796 to 1815. Tradition says the farm-house was burned, but at what time and under what circumstances is not now known. The present farm-house had but one or two plastered rooms about 1830 and even later. Mr. Carpenter used to keep his horses, at one time as many as five in the west half of the house cellar, a wide door at the southwest corner giving access at a level with the cellar bottom. The cattle were kept in the only barn on the place—the present hay barn on the plain. Mary Brown, widow, was appointed administrator, on the estate of Rowland Brown, July 13, 1801, and on Aug. 10 of the same year returns an inventory, from which we extract a few items of interest. Eight sheep and three lambs are appraised at $20. Three cows, $45; one chaise horse, $50; one old mare and one four-year old mare, $60; one pair oxen, $38; about 30 bushels of corn, $30; about 50 bushels of barley, $33.33; about 40 pounds of sheep's wool, $17.04. After the death of the father and previous to 1814, the farm was divided between Rowland Brown, (Jr.), and Ruth Brown, the former taking the southerly half and the latter the north part. July 6, 1814, Rowland Brown sells his portion of the farm to Timothy Peckham, and it was probably rented as before. Ressell Pierce, Updike Whitford and Gardner Wilcox are named as residents here for one or more years up to 1826, when the farm was leased at auction to the highest bidder and hired by N. C. Peckham, who began housekeeping here a few weeks after his marriage; and it was here that J. G. Peckham, first Master of the R. I. State Grange, was born. This southerly part of the farm is sold by Timothy Peckham March 5, 1827, to Peleg Brown. The will of the latter is dated July 27, 1831, and we find it admitted to Probate Jan. 13, 1832. This instrument bequeaths his farm near the village of Kingston to his two sons, Joshua C. Brown and Palmer Brown, to be equally divided between them. Feb.

23d, 1832, Palmer Brown and wife sell their share to Nathaniel Armstrong, and the following March 2d, J. C. Brown and his wife sell their part to the same party. March 26, 1835, N. C. Peckham purchased of Ruth Brown land including that portion of the farm north and northeast of the farm buildings, which gives it so much greater width at the east end; and April 11, 1836, sells about 40 acres to Nathaniel Armstrong, and the bounds of the present farm—avenue excepted—are defined. On Jan. 8, 1844, the will of Nathaniel Armstrong was admitted to probate, and his sons, Thos. J. and N. C. Armstrong, appointed executors. The will provided for the disposal of the farm to pay certain bequests. Therefore, on Dec. 2, 1844, we find the farm sold by the executors to Oliver W. Watson, who moved here and made it his home till the time of his death in 1875. Mr. Watson finished and plastered most of the house, took the stone top from the chimney and rebuilt it with brick, and also built the ell at the northeast of the house. He also built the small barn now torn down. In 1869, John H. Tefft, son-in-law of Mr. Watson, came here to reside, and in 1871 the farm barn was built. After the death of Mr. Watson, Mr. Tefft continued to manage the farm until the spring of 1880, when it was leased to George Potter, who lived here and carried on the farm eight years, and was the last occupant previous to its sale to the State. During the spring and early summer the question of the location of the Experiment Station was being considered, and finally in June the purchasing committee bargained for the property. The serious illness and death of Mr. Tefft, with other reasons, delayed the transfer by deed till Sept. 11, 1888, when the State received a deed of the property from Mrs. Phebe A. Watson and Mrs. Mary E. W. Tefft. Mr. Potter followed the ordinary course of culture practiced in the vicinity—corn, potatoes, oats and grass, and kept the first few years 9 cows, 1 bull, 2 horses and 30 sheep. The last four years he made milk for market and increased his stock to fourteen cows, one pair oxen and two horses, selling off his sheep. During the season of 1888 the plowed ground was seeded to oats and the crop secured by Mr. Tefft, and the pastures stocked with cattle. The hay crop was cut on shares and one-half the hay became the property of the State with the farm.

This brief outline of the history of the farm we think of suffi-

cient importance to form a part of the introductory literature of the Station. The original 250 acres was kept, with occasional exceptions, as one farm till after the beginning of this century, when it was divided and reduced to the present number of acres. How many years the Indians tilled the easily cultivated plain lands of this section before the advent of the whites, we have no means of knowing, but that they grew a supply of corn for their own use and for barter, we are assured by the early historians; hence the earliest white settlers did not always find a soil of virgin fertility. It is not unreasonable to suppose that the light plain lands, free from stone, would be selected by the rude cultivator with his rude tools for the planting of his corn fields, in preference to the more hilly and stronger lands,—thus reducing the fertility of those lands least able to bear the loss. Since that time, American agriculture has ever been a depleting process. That farmer has been called successful who could show a bank account as the result of his years of cultivation, although his fields were bankrupt in regard to their supply of plant food. This fact, true of the *land owner*, is magnified in the *tenant* farmer, and when we consider that this farm has been *leased* for rather more than *fifty per cent.* of the last one hundred years, we are not surprised at the scarcity of plant food in some of the fields, as evinced by the natural plant growth. How to till and crop such fields and secure to the farmer of ordinary means a fair return for his labor and expense, and at the same time stem the tide of continual reduction of plant food in the soil, is a problem, the solving of which is of vital importance to American agriculture.

PHYSICAL DESCRIPTION.

The Rhode Island State Agricultural School and Experiment Station Farm is located in the town of South Kingstown, Washington County, on the east side of the New York, Providence and Boston Railroad, known as the " Stonington Line," not far from the Kingston station. The latter point is 27 miles south of Providence and 17 miles northeast of Westerly. It is about six miles from the farm to Narragansett Pier, and the same distance to the "North Ferry," on the road to Jamestown and Newport. The farm lies northeast of the Kingston railroad station and north of the highway leading to Kingston village. The distance from the depot to the avenue is one and seven-tenths (1.7) miles, and from the avenue to the village post-office about three-tenths of a mile. The farm is approached along the avenue a distance of 1800 feet. This avenue is most of the way five rods or more in width, and formed part of a pasture. At the widest point a ledge of rock crops out, from which stone for building the house portion of the Kingston Jail was obtained some years ago. A good road is being constructed along this avenue to the farm. The former approach was through three pairs of bars or gates and along a cart-path, indicated by the parallel dotted lines on the accompanying map. The south boundary of the farm is practically a straight line extending from the east end in a northwesterly direction 5774.19 feet, broken by the avenue at a point 815.53 feet from the east end. The easterly portion of the farm extends about to the crest of the hill on the east, and is bounded on the north by a " drift-way," over which the farm has a " right of way " to the "North road," some 1400 feet east of the farm. This portion of the farm is 1909.55 feet E. and W., by about 1625 feet average width N. and S. The westerly portion of the farm is bounded on the north by a line practically parallel with the south line and 765 feet from it. On the west is " Thirty Acre Pond " and the Chipuxet river. The

elevation of contour lines—irregular lines on the map designated by numbers—is calculated above *mean sea level*, and the lines are drawn to indicate five feet difference in level. The pond is 98 feet above the mean sea level. The plain land, from the woods on the west to the line numbered 113, and near the south end of which is a little enclosure with a cross indicating graves (Niles burying ground), averages about 118 feet, or twenty feet higher than the pond with the exception of the basin around which the circular contours are drawn; here we find permanent water at a level of nearly five feet above the pond. This plain is a tract of level, sandy-loam land with a yellow loam subsoil, under which in many places is a *very thin* stratum of clay before striking a porous gravel of indefinite depth. The gravel is found at from two and a half to five feet from the surface. There are no stone to interfere with cultivation, and corn and grain crops do well when the land is in proper condition; most of this is badly exhausted. The old barn, enlarged and repaired for a hay barn, stands near the end of the old cart-path. A piece of woodland covers the gentle slope from the plain to the river on the west, and includes a few large trees at the north end, some good young wood at the south end, while the middle portion is hardly better than brush. The fences, indicated by dotted lines across the plain near the basin and south and east of the barn have been removed. The north and south fence is of stone, and just east of it the nursery stock was set last spring, the sod being very thin (seeded with oats in '88), and therefore easily cultivated. Just east of the "Niles burying ground" is a shallow valley through which a tiny brook—dry during drouths—winds its way; this is "Race Hollow," and serves as the channel for quite a body of surface water during freshets. As we come to the second irregular line, numbered 113, just east and north of the brooks, we reach the foot of the hill. The character of the soil begins to change from a dry, sandy loam to a moist, retentive clay loam, with clay and hard-pan subsoil. Bowlders appear and the ledge crops out as indicated on the map by a few shaded lines near contour marked 113. As we go east, the rise is quite uniform and constant. The farm-house is found to stand on ground 173 feet above mean sea level, or 75 feet above the level of the pond. The highest point is the S. E. corner of the farm, 233.5 feet, or 135.5

feet higher than the pond. The wood indicated in the pasture is more of a grove than woodland proper, low-branching trees of several varieties growing moderately near together. The ground here is very wet and springy, with a strong tendency to grow bushes, as is also the condition along the depression marked by the brook and extending to the east boundary line about midway of the farm. There are 57.2 acres of cultivated land on the plain and 23.5 on the hill northeast of the farm building. This latter was divided by stone walls into six different lots. The walls have now all been removed (excepting a few foundation stone) and used in the construction of roads and driveways; and as time shall make it possible to clear it from bowlders, it will make a valuable field for grass, fruits or cultivated crops. The old orchard contains in area 1.5 acres and 57 apple trees, 3 pear trees and 1 plum tree. These having been set at different times and long neglected, are of all sizes and degrees of growth. A thorough pruning last spring removed much dead wood and is inducing some growth the present season. The pasture lands included 42 1-4 acres. Of this, that portion south of the brook—the southeast section of the farm—is, excepting the wooded part, equally as good land as the cultivated fields, and when cleared will be valuable for horticultural or other work. The "ox pasture" northwest of the farm buildings, with the exception of the extreme N. W. corner, is so uneven and rocky as to be only valuable at present for pasture. The total area of the farm is 139.65 acres.

There are three living springs on the farm: one in the southeast corner of the pasture woodland, another near the southwest corner of the ox pasture by the cart-path leading to the plain, and the third in the ox pasture. The "Niles burying ground," mentioned in the historical description is on a sandy knoll just west of Race Hollow. The graves are all marked by rough wall stones set on end in the earth, with no mark whatever on any to distinguish the resting place of one from another. At least thirty-five or forty persons lie buried here. At another point, just north of the wall running east from the farm buildings, other graves are indicated on the map by three small crosses, and marked by the same rude headstones as those on the plain. Here by the side of the cultivated field, and under the shadow of a now fine linden tree, are

supposed to lie such of the family slaves and servants as ended their life on this farm. Twelve graves can be counted.

FARM BUILDINGS.

The farm-house is a two-story building, 36¾ x 28½ feet, with old-fashioned stone chimney, topped above the roof with brick. It is now painted white and furnished with blinds. An ell 22 x 20 feet is located at the northeast corner near the well. The barn stands northeast of the house and is 36½ x 32½ feet, and well built, some eighteen years ago, by Mr. J. H. Tefft. There is a floor through the middle and stalls without floors on either side. The scaffolds will hold about thirty tons of hay. The sides of the barn are shingled. A small barn 30 x 16 feet, east of the one just described, was in very poor repair and has been torn down. There are also a few small buildings used as a wagon-shed, wood-shed, corn-house and poultry-house, all built many years ago, with the exception of the poultry-house, which is comparatively new. The barn on the plain was 30 x 20 feet, and for very many years was the only barn on the farm. The building was in a very dilapidated condition and in imminent danger of being blown to pieces; one end was entirely out, doors gone and boarding off. The building was raised, posts spliced, new silled, and ten feet in length added to the open end and the outside entirely covered with shingles, excepting the west end, which was comparatively tight. The old scaffolds were removed and the structure fitted for a hay barn. This was done during the winter of '88–89. Last spring a small building 10 x 20 feet and about 7½ feet high was erected as a temporary and convenient workroom and store-house for the apiary. It stands near the apiary at a point just east of Race Hollow and near where the ledge crops out. When a larger building, with basement for wintering bees, is provided, the present structure will be used for poultry. Additions to the farm barn are being made for stable room for teams and shed room for wagons and tools. A building 20 x 48, with fourteen-foot posts, stands north and south just west of the barn, and furnishes two high sheds for loads of hay or grain, and at the south end a room 20 x 20 feet, with chimney and wide roll-door, for use as a carpenter and repair

shop. Over this is a pleasant room for a farmer's office, seed room, &c. Extending east and west and connected with the rear of the barn is a low building, 118 x 20 feet, with a concrete floor. The west end, 20 x 20, is a manure pit, the bottom some 4½ feet lower than that of the stable, but opening by wide doors at the west on a level with the surface of the ground. The stable is sheathed on the inside for warmth, and stalls are provided for seven head of cattle and eight horses. At the east end are two box-stalls. Floor space is provided for cleaning horses. A cistern has been dug in the feed room and a force-pump supplies a watering tub in the floor-way. Extending south from the east end is a shed 80 x 20 feet. The south end of this shed is finished to correspond with the repair shop and office. Here a room 20 feet square is provided with a chimney and designed as a convenient place for slaughtering. A shed 23 x 20 feet for carts is next the slaughter-room, then a high shed 14 x 20 feet and a room 23 x 20 feet, in which to keep mowing machines, grain drills and farm machinery, occupy the rest of the space. Each of the 23-foot spaces is floored, and considerable space for storage secured easy of access from the high shed.

These additions are all of wood, on good stone foundations well laid, and provided with drains to take out surplus water. The buildings are shingled, sides and roof, and the stable further protected with building paper laid under the shingles on the sides. The old farm barn will be used for storing hay on the scaffolds, and the old stables for feed, harness and carriage rooms. All the old walls around the house and barn have been removed and the grounds graded for a lawn.

The Chemical Laboratory, to be constructed with an approriation made by the State for the purpose, will be of stone and stand some 300 feet southeast of the house. The south half of the building will be used for the chemical work of the station and director's office, and the north half for the present will be used as chemical lecture room and laboratory for the use of the school. A more detailed description will be given in a later bulletin.

GEOLOGICAL DESCRIPTION.

Late in the fall of 1888, Rev. Edgar F. Clark was invited to visit Kingston and make a geological examination of the rocks and soil of the station farm. He came, accompanied by Prof. T. Nelson Dale. Investigation was made by digging from three to five feet deep in many places about the farm and taking samples of the soil, which were afterward microscopically examined. Both Mr. Clark and Prof. Dale occupy important positions in connection with the U. S. Geological Survey.

Report of Rev. Edgar F. Clark upon the Geology and Mineralogy of the R. I. State Agricultural Experiment Station Farm:

The geology and mineralogy of the Station Farm deserves to be known by all the citizens of Rhode Island, but especially by her yeomanry, so that future experiments may not only be better understood, but also more easily applied to the varying soils of the commonwealth.

The underlying rock of the farm is *Gneiss*. Its composition is quartz, a pinkish feldspar (orthoclase), and a black mica (biotite). Leaving out the consideration of color, the constituents are the same as for granite, but are differently disposed in the latter. The decay of this rock yields silica, alumina, potash, soda, magnesia, and iron, of which silica, or quartz, and alumina, or clay, are the chief parts. The soils resulting are largely silicious (sandy) and argillaceous (clayey), in varying proportions. But little lime is manifest, the minerals being almost entirely confined to the above list. The gneiss crops out at the widening of the avenue leading from the public highway to the farm, and was formerly the site of a quarry. Another outcrop occurs in a southwesterly direction from the farm-house. The *strike* of the rock at the quarry, according to Prof. T. Nelson Dale, who rendered most valuable assistance, is N. 67° W., and the *dip* 20° northerly. This basal rock is traversed by joints, the principal ones striking E.—W., and dipping vertically.

The grit of the soil, the pebbles and the superficial bowlders all evidence their origin from this gneiss, while yet, from the extent of this

rock, they may have been brought some distance from the action of the Glacial Period. These outcrops appear at the eastern end of the farm, where the surface rises, being a part of "Kingston Hill."

A large part of the farm lies at the base of this elevation and belongs to "Kingston Plain." Tests carefully made at several places across this plain gave a black soil upon the surface, of varying depths, much of which is of vegetable origin, underlaid by an impure clay, frequently colored by iron, resting over gravel and pebbles of unknown depth. A peculiarly hard soil that extends over much of Kingston Hill is locally known as "hard pan," and doubtless had its origin from the disintegration of feldspar prior to the elevation of the hill, and was deposited from water under topographical conditions very unlike those at present existing.

The station farm furnishes, therefore, an apparent variety of soils, giving excellent opportunity for experiments, and soils that represent much of the territory of the Commonwealth.

The benefit that will result to the State is bounded only by the resources at command, and the fidelity with which experiments are pushed, and the yeomanry avail themselves of the great benefits accruing from the munificence of the nation and the State.

EDGAR F. CLARK,

State Collector of Fossils for the United States Geological Survey.

STOCK FEEDING.

BULLETIN No. 3.

H. J. WHEELER.

INTRODUCTION.

KINGSTON, Sept., 1889.

Prof. Justus von Liebig and his followers in the same line of work have proven to us by chemical investigation and actual experiment, that plants have the power of assimilating carbonic acid gas from the air* and mineral elements from the soil and elaborating these into food for animals. They have found that different families of plants require a supply of the different mineral elements in varying proportions, and that with most plants and upon most soils only the extra addition of potash, phosphoric acid and nitrogen is necessary.

This subject has come to be well understood and with untold profit to our American farmers. The question of feeding animals has undergone, and is undergoing a similar thorough investigation which presents many analogies to plant nutrition and promises to lead to no less valuable results. It is but a few years since the attention of our farmers was first called to the results already obtained in Europe. Though the subject has been much less thoroughly discussed than the fertilizer question, yet the farmers of the country are beginning to talk about "feeding rations," and to

* The free atmospheric nitrogen has also recently been shown by Hellriegel and others, to be taken up by some leguminous plants, peas, vetch, lupine, beans, serradella, etc. See, among others, Hellriegel und Wilfurth "Untersuchungen über die Stickstoffnahrung die Gramineen und Leguminosen," Beilageheft Zeit. des Vereins f. d. Rübenzucker Industrie d. D. Reichs, Nov. 1888. Also Atwater Bulletin No. 5. Storrs School, Agricultural Experiment Station, Connecticut, 1889, and Atwater American Chemical Journal, 1885, p. 365.

manifest a decided interest in relation to all work carried on in this line. Judging from the experiments already conducted and the practical application of them already being made in Europe, we have every reason to hope that their application in this country modified of course as experiment may show is necessary to suit our climate and other conditions, may result in an immense saving annually even to the small State of Rhode Island. Our advancing civilization has long since rendered stall feeding necessary, but the wonderful discoveries in chemistry made in the first half of this century, were the first means toward its more *economical* application. We might well replace the term "*Scientific feeding*," by that of "*practical* and *economical*," or even "*rational feeding*," since the ***most economical system of feeding possible*** is the one and common aim of both farmer and scientist.

The only difference between the two has been that the former was obliged to weigh his hay on his pitchfork, and feed both grain and hay without any knowledge of their composition, or their relative value in the formation of fat, flesh, milk or wool, while the latter found by analysing the different parts and products of the animal, *what was to be built up*, and then by analysis of the grain and hay, *what material was at his disposal*, after which by actual experiment, he sought to learn if any *one* of these compounds of the food alone, or a combination of *any two* of them, or perhaps a combination of all would give the best results, and if so, then in what proportions. This then is *rational* or *scientific feeding* and in so far as the farmers of Rhode Island are inquiring whether their Linseed meal is "old" or "new process" i. e. how much oil it contains, or how much nitrogen is contained in their wheat bran, cottonseed meal or other grains and fodders, to just that extent are they becoming scientific farmers, and trying to make the same amount of hay and grain winter one more cow than it ever did before. One object of this and other experiment stations is to inform the farmers *what has been done*, to answer as far as they can be answered, all questions in relation to the analysis of crops and the compounding of feeding rations, and to ***conduct such experiments as the resources of ordinary farms forbid*** as well as to assist by advice so far as may be, in the carrying out of the more simple experiments upon their own farms.

THE COMPOSITION OF ANIMALS AND ANIMAL PRODUCTS.

The chief constituent is water, consisting of hydrogen and oxygen.

Next perhaps in amount is the flesh or muscles consisting of carbon, nitrogen, hydrogen, oxygen and sulphur. The *bones* are largely built up from the mineral matter of the plant as the following analysis copied from Bloxom's chemistry shows:

COMPOSITION OF THE BONES OF OXEN.

Animal matter	30.58
Phosphate of lime	57.67
Fluoride of calcium	2.69
Carbonate of lime	6.99
Phosphate of magnesia	2.07
	100.00

Fat contains carbon, hydrogen and oxygen but is *free from Nitrogen.*

Blood contains all the elements found in the flesh together with a large number of mineral elements. It is the carrier of the material dissolved from the food, to the different parts of the body. We might further enumerate and give the composition of all the different secretions and their office so far as known in dissolving the food or in maintaining the different functions of the animal system: This, space, and the special object of this bulletin does not allow.

Milk, one of the chief animal products contains on the average, about 13 per cent. of solid matter, the rest being water. The solid matter is essentially composed of fat, milk-sugar, *nitrogenous compounds* similar to those in flesh, and mineral matter rich in phosphates.

Wool is a complicated product containing both fatty and nitrogenous compounds and also soluble potash compounds which are removed by washing.

All these products of animal life are built up from the plant, the animal adding thereto only the oxygen of the air, throwing off in return water and carbonic acid gas. This latter is absorbed by plants (*i. e.* those containing chlorophyl), the carbon is retained and oxygen again exhaled.

CONSTITUENTS OF PLANTS, THEIR DIGESTIBILITY, ETC.

MANNER OF STATING FODDER ANALYSES AND EXPLANATION OF TERMS USED.

The following is a chance analysis of Timothy (Phleum pratense) hay and is used here merely to illustrate general principles. All other fodders contain the same constituents, varying of course in amount according to the nature of the soil, fertilizers used and time of harvesting:

	Total Composition.		Per cent. of digestibility of constituents for Ruminants.*	Amount digestible in 100 lbs. original substance.	Nutritive ratio.
	Original Substance.	Dry Substance.			
Moisture at 100° C	10 55				
Dry Substance	89 45				
Crude Ash	4 20	4 69			
Crude Proteine, (nitrogenous matter)	8.06	9 02	57	4.59	
Crude Fat, (ether extract)	2 37	2 65	48	1.14	1: 10.5
Non-nitrogenous Extract Matter, (carbohydrates	48 69	54.43	62	30.19	
Crude Fibre	26 18	29.21	58	15 15	

Moisture at 100° C. is that which is expelled at the boiling point of water i. e. 212° Fahrenheit. In fact all hay or grain left exposed to the air contains when dryest, several per cent. of water. This amount varies with the amount of moisture in the atmosphere.

Dry matter is what remains after entirely expelling the water.

Crude ash consists of the mineral matter of the fodder.

* Digestibility assumed the same as for mixed hay of medium quality.

Crude Proteine is a collective name under which all the nitrogenous matter of the plant is grouped. It is determined by finding the amount of nitrogen and multiplying it by 6.25. Albumen, contained in the white of eggs as well as the albumen-like substances (*albuminoids*) of the plant if dried and analyzed, are found to contain about 16 lbs. of nitrogen in 100, or $100 \div 16 = 6.25$ i. e., for every pound of nitrogen found we assume that 6.25 times as many pounds of nitrogenous substances were present. Under this heading are also grouped the *amides*, crystalizable nitrogen compounds, of which asparagine found in the young asparagus shoots is typical. These compounds are most largely found in young plants and in root crops, and owing to their probably lesser nutritive value are often determined separately. They might well be termed the "*portable form*" of the albuminoids, since the albuminoids in the seed or plant are converted into this form to be transported to other parts of the plant for re-deposition. In this respect they are analagous to the *peptones*, the soluble form into which the nitrogenous portion of the food is changed in the stomach of the animal, and in which form it can be taken into the circulation for the rebuilding of tissue, and the production of milk, wool, etc. Some writers use the term "*proteine*" and "albuminoids" synonymously.

Crude Fat, (ether extract), consists of the portion extracted from dried plants by dry ether, and may in the case of some grains be nearly pure fat, or in case of dried plants contain some wax, and the green coloring matter of the plant called chlorophyl. This latter is cónsidered only slightly, if at all, digestible.

Non-nitrogenous Extract Matter, also called "nitrogen-free extract matter" is found by subtracting the sum of the ash, fibre, fat, and proteine, from 100, and contains the carbohydrates such as starch, sugar and gum.

Crude Fibre, also called "cellulose" is the woody fibre of the plant remaining after a treatment with acid, alkali, alcohol and ether, of which cotton fibre and paper pulp are examples.

In the analysis on page 36, in the columns from left to right is given (1). The pounds of constituents *in 100 lbs. of original substance.* (2.) The amount in 100 lbs. of *absolutely dry substance.* (3.) The per cent. of number of pounds in 100 of proteine, fat,

etc., actually dissolved or digested by animals. (4.) The total amount of digestible material in 100 lbs. of the original substance. (5.) The nutritive ratio or number of pounds of digestible carbohydrates or equivalent, for every pound of nitrogenous matter. It is hoped that this arrangement of analyses will render them easily available to the farmer in calculating rations and at the same time convenient for compilation.

DIGESTIBILITY OF FODDERS.

To trace the movement of the food from the time it is mixed with the saliva in the mouth, through the stomach or stomachs, noting the action of the various juices of the stomach, the effect of the bile in rendering available the fat, and so on through the intestines, though interesting, is not necessary to our present purpose. Briefly stated, a large portion is soluble (digestible), is absorbed and goes to form the blood, and repair the wastes of, or to increase the animal system.

The insoluble portion which can consequently have no nutritive value, is voided in the solid excrement.

The urine contains practically such other material wastes from the system, as do not pass off through the skin or in the exhalations from the lungs. Since then this is the only outlet from the system for the nitrogen which has once been dissolved from the food,[1] its quantity is a measure, in the case of hungering animals, of the amount of their own flesh consumed, and in other cases of the total *material waste* of the system together with so much as may (in case of one-sided feeding) be transformed and excreted without being utilized by the animal.

The digestible carbohydrates are oxidized and exhaled from the lungs in the form of carbonic acid gas and water.

Since nutritive value of fodders is almost wholly dependent upon the amount of digestible matter contained in them, German

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[1] The amount of nitrogen claimed by some to escape from the animal in the gaseous form of nitrogen or ammonia, is too small for practical consideration. In the Journal für Landwirthschaft, 1886, S. 149, Th. Pfeiffer discusses the small quantities of mucine, intestinal epithelium, and matter coming from the bile all of which contain nitrogen and are voided with solid excrement.

investigators have tested the digestibility of different fodders with the various classes of animals. For horses, cows and swine for example, wide variations have been found.

THE VALUE OF DIGESTIBLE CRUDE FIBRE.

Playing over the coal fire with a peculiar blue flame, we have often noticed the combustion of a gas, which becoming mixed with air sometimes causes a slight explosion.

Shonld this gas pass up the chimney and escape combustion to carbonic acid gas and water, a consequent loss of heat would result. Recently, careful observation has shown an analogous loss from marsh gas (CH_4) which is given off by animals, in varying quantities. This is supposed to result from a so-called "secondary digestion" or fermentation, caused by organized ferments (microbes) and various experiments have been tried to determine whether this gas came from the proteine, fat, or non-nitrogenous extract matter or the crude fibre. In any case an amount of heating value equivalent to the heat produced by its combustion to carbonic acid gas and water is thus lost, and the nutritive value of the fodder consequently lowered. To aid in solving this question Frans Lehmann[1] has instituted an experiment with sheep from which he concludes after a summary of the previous results and methods of investigation by Weiske and others, that the *marsh gas comes from the crude fibre.*

He furthermore found the relative value of the digestive non-nitrogenous extract matter to that of crude fibre in the relation of 100:61. Further experiment showed the relation between the value of cane sugar and the digestible crude fibre of oat straw to be as 100:75.7.

The above author has also planned other experiments for the purpose of throwing more light upon, and to help settle more definitely the real value which we may ascribe to digestible crude fibre.

Prof. E. von Wolf, at a meeting of German physicians and scientists held at Wiesbaden, Sept. 20, 1887,[2] in giving a summary of

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[1] Jour. f. Landw, 1889, S. 251.
[2] Die Landw. Versuchs Stationen 34 S. 456.

the investigations conducted for several years by him at Hohenheim and by L. Grandeau and Leclerc in Paris, asserts that "*the digestible crude fibre, whether in coarse or concentrated fodders has apparently no value for the sustenance of the horse at rest in the stall, nor in enabling him to perform work.*"

EFFECT OF EASILY DIGESTIBLE FOOD.

It has been found that the addition of easily digestible food like potatoes and roots, to other fodders lowers the digestibility of the constituents of the latter.[1] The digestibility is not appreciably lowered, however, if the amount of dry matter of the roots, etc., does not exceed 12 per cent. of the whole amount. In case it amounts to ¼ of the whole amount, the digestibility of the proteine, which is most seriously affected, is lowered one-tenth, if increased to two-thirds of the total dry matter, the digestibility of the proteine is lowered one-fourth.[2]

ARTIFICIAL DIGESTION.

An artificial method for determining the digestibility of fodders by use of the natural juices of the stomach has been proposed by Stutzer.[3] Further investigations have been made by Th. Pfeiffer[4] and Stutzer for the purpose of finding a method for dissolving from the solid excrement the mucine, intestinal epithelium, biliary products, etc. The digestible nitrogenous matter being found by subtracting the nitrogen remaining in the solid excrement from that originally contained in the fodder, necessitates of course if exact results are desired, the previous removal of all nitrogen in the former not coming directly from the food itself before it is subjected to analysis. From the later investigations Th. Pfeiffer[5] finds that for this purpose, the solid excrement should be treated with the hydrochloric acid and pepsin, and alkaline pancreatic solutions,

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[1] Die Ernährung der landwirthschaftlichen Nutzthiere Gekrönte Preischrift von E. von Wolff, Berlin, 1886, S. 156-175.

[2] Landwirthschaftlicher Kalender für, 1890, S. 98.

[3] Journal für Landwirthschaft, 1880, S. 195.

[4] Journal für Landwirthschaft, 1885, S. 149.

[5] Zeitschrift für physiologische Chemie, 11 S. 1.

before being dried and by such a procedure somewhat higher coefficients of digestibility were found *which agreed well with the results by the artificial method.*

H. Weigmann[1] of the agricultural experiment station at Münster, finds that the digestibility of the proteine in cacao in the human system and by the artificial method is the same. Other work points in the same direction. Should the method prove itself after sufficient comparisons have been made, to be wholly trustworthy, it will be invaluable for determining the digestibility of such material as can now only be determined by feeding mixed *with* other fodders of previously known digestibility. For the preparation of solutions as at present used by Stutzer, see "Die landw. Versuchs-Stationen," 1889, S. 321.

The digestibility of but few American fodders, has as yet been determined, though Jordan,[2] Ladd,[3] Armsby, Babcock and others have made a beginning.

The determination of the digestibility of all our American fodder articles, for the different classes of agricultural animals is much to be desired.

CALCULATION AND EXPLANATION OF "NUTRITIVE RATIO."

Referring to the analysis on page 36, we see that 8.06 pounds of proteine are found in 100 pounds of original substance, and further under "per cent. of digestibility of constituents" that in every 100 pounds of proteine, 57 pounds are digestible, hence $8.06 \times .57 = 4.59$ pounds, the *total amount* of digestible proteine in 100 pounds of the fodder. In the same way we find $(48.69 \times .62) = 30.19$ lbs. of digestible non-nitrogenous extract matter, $(26.13 \times .58) = 15.16$ lbs. of digestible crude fibre and $(2.37 \times .48) = 1.14$ lbs. of fat.

Since one pound of fat whether burned artificially or changed to carbonic acid gas and water within the animal, produces about $2\frac{1}{2}$ times as much heat as one pound of carbohydrates, starch, sugar or gum, the amount found to be digestible is first multiplied by $2\frac{1}{2}$ and then added directly to the amount of digestible carbohy-

[1] J. Koenig, Chemie der menschlichen Nahrungs und Genussmittel, 3 Aufl. S. 48.
[2] Bulletins and Reports of the Maine State College Experiment Station.
[3] 4th Annual Report N. Y. State Agricultural Experiment Station, 1885.

drates (crude fibre and non-nitrogenous extract matter) from which we calculate our nutritive ratio. Digestible fat $(1.14 \times 2\frac{1}{2})$ $=2.85$ its carbohydrate equivalence. Now $(2.85+30.19+15.16)=$ 48.20 or in 100 lbs. of the hay we have *the equivalent* of 48.20 lbs. of carbohydrates, and this sum, i. e., that of the three non-nitrogenous constituents is termed by Whitcher[1] and others the "*carbohydrate equivalence.*"

As seen above 4.59 lbs. of proteine are digestible, and our total carbohydrate equivalence we have found to be 48.20 lbs., hence our nutritive ratio may be stated as follows: 4.59:48.20 or in other words for every 4.59 lbs. of digestible proteine there are present the equivalent of 48.20 lbs. of digestible carbohydrates; for one pound of proteine there are as we can find by division $(48.20 \div 4.59)=10.5$ lbs. of carbohydrates or our nutritive ratio is **1:10.5** as stated in the preceding analysis.

THE FUNCTION OF THE VARIOUS CONSTITUENTS OF FODDERS IN THE ANIMAL ECONOMY.

SOURCE OF NITROGENOUS MATTER.

Since nitrogen is an essential constituent of flesh, milk, bone, hair and wool, the proteine, the only nitrogen containing portion of fodders, is the only and an absolutely necessary material for their production.

SOURCES OF FAT.

Fat appears to be directly used in increasing the fat of the animal though evidently undergoing in the various processes, certain modifications. Babcock[2] after feeding large amounts of cotton seed meal to milch cows, thereby affecting the composition of the milk, failed to find therein either by microscopical investigation or chemical test, any trace of the characteristic cotton-seed oil, and pronounced the product, so far as all known means of examination or appearance could show, to be pure butter fat. That the *carbo-*

[1] Bulletin No. 4, N. H. Ag'l Exp't Station, p. 15, Nov. 1888.
[2] 6th Annual Report of the New York Agricultural Experiment Station p. 388.

hydrates (non-nitrogenous extract matter and fibre) *may likewise take part in the formation of fat has* come to be universally accepted.

Innumerable experiments have also shown that the *proteine also contributes to the formation of fat.*

THE MINERAL CONSTITUENTS.

The mineral portion of the plant plays an important part in the animal economy, for from it the bones are largely built up, and the mineral elements are essential constituents of the blood and various juices of the animal system. A goat fed at Proskau[1] on being deprived of lime and phosphoric acid in its food died after fifteen days.

EFFECT OF FEEDING SINGLE CONSTITUENTS OF FODDERS.

A hungering animal has been found to consume its own flesh and fat, the nitrogen of the former reappearing almost wholly in the urine and the fat in the exhalations from the lungs as carbonic acid gas and water. If now a *moderate amount of proteine* is fed the rate of loss of flesh is not only not *materially lessened*, but the amount of excreted nitrogen in the urine is not only equal to that previously found, but is increased by nearly the whole of that in the added proteine. Only by feeding proteine in enormous quantities can this loss of flesh be even temporarily prevented.

If *under like conditions* we try to feed *fat alone* it neither *prevents nor lessens* the loss of flesh, though the total amount of fat in the body may be thereby increased. If long enough continued the animal dies. In a similar case by feeding exclusively carbohydrates, the *loss of flesh is lessened*, but cannot be entirely prevented. The carbohydrates serve however to protect the fat of the body by suffering oxidation in its stead. By *combining fat and carbohydrates* in such a case the loss of flesh still continues. In fact experiment has conclusively proven that only by feeding a *combination of proteine, fat and carbohydrates* can an animal be kept for any length of time without a loss of flesh or health.

[1] Armsby's Manual of Cattle Feeding, p. 434.

A "maintenance ration" is such a combination and amount of these several constituents as merely sustains an animal without gain or loss. The requisite proportion of these different constituents for various animals kept for various purposes, has been found to be widely variable. With different classes as well as for different conditions of animals of the same class, practical tests have been made to find out in what proportion the constituents of fodders should be combined to give the greatest returns with the least amount of food. In this way have come to be established in Germany the so-called "feeding rations" or "standards." These together with analyses of fodders, rates of digestibility, etc., for compounding rations, are published annually in a *diary* or calendar form, together with a mass of other general information for the use of the practical farmer. They are in general use throughout Germany.

EFFECT OF LABOR, DARKNESS, TEMPERATURE AND OTHER CONDITIONS.

Animals at work exhale more carbonic acid gas and water than when at rest, and it was earlier falsely concluded that the fat and carbohydrates were the only sources of heat and muscular energy. Present authorities all agree however that the chief nutritive constituents, stand in their value *for the production of mechanical labor* in the following order, viz: first, proteine, then fat and finally carbohydrates.

In the dark less carbonic acid gas and water is exhaled than in the light which suggests fattening in darkened apartments. This is already successfully practiced in America in the fattening of poultry and calves.

An exposure to low temperature is the same in its effect as labor. High temperatures are as would be expected, unfavorable.

The radiation of heat from the animal varies as the surface, hence more food is required proportionately, for four animals weighing together one ton, than for but two of the same total weight.

Excessive consumption of water leads to a greater excretion of nitrogen and consequent waste. Too much salt leads to the above, though in *small* quantities, salt is decidedly beneficial.

FEEDING TABLES AND STANDARDS.

We must consider in planning a system of feeding. (1.) *What fodder articles we already have at disposal upon the farm.* (2.) *The cost of the various other materials in the market together with their chemical composition, the cost of carting and their effect on the quality of the milk and butter, and the general health of the animal.* (3.) *The amount of plant food left upon the farm in the form of stable manure, as affected by the fodders used.*

These are questions largely affecting individual circumstances, and must be decided by every man for himself.

To meet the wants of those who desire to see if they are now feeding most economically, as well as for assistance in modifying the rations if desired, or in compounding new ones, we now append a series of tables.

FEEDING STANDARDS AND TABLES.

Table I is essentially that published by E. von Wolff in the Landw. Kalender (Agricultural Calendar), for the use of the German agriculturist. It is the same as printed generally in this country, and shows the total dry matter and digestible amounts of the various constituents required by animals under varying conditions.

TABLE I.—A. POUNDS PER DAY REQUIRED FOR 1,000 LBS. LIVE WEIGHT.

KIND OF ANIMAL.	Total dry organic matter.	Digestible Constituents of the Fodder. Albuminoids and Amides, (Proteine.)	Total carbohydrates, (from fibre and non-nitrogenous extract matter.)	Fat.	Amount of nutritive matter.	Nutritive ratio.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
Oxen at rest in stall	17.5	0.7	8.0	0.15	8.85	1: 12.0
Sheep, wool producing, (coarse breed)	20.0	1.2	10.3	0.20	11.70	1: 9.0
Sheep, wool producing, (finer breed)	22.5	1.5	11.4	0.25	13.15	1: 8.0
Oxen at medium work	24.0	1.6	11.3	0.30	13.20	1: 7.5
Oxen at hard work	26.0	2.4	13.2	0.50	16.10	1: 6.0
Horses at light work	20.0	1.5	9.5	0.40	11.40	1: 7.0
Horses at medium work	21.0	1.7	10.7	0.60	13.00	1: 7.0
Horses at hard work	24.0	2.4	12.5	0.80	15.70	1: 6.0
Milch cows	24.0	2.5	12.5	0.40	15.40	1: 5.4
Fattening oxen, 1 period	27.0	2.5	15.0	0.50	18.00	1: 6.5
Fattening oxen, 2 period	26.0	3.0	14.8	0.70	18.50	1: 5.5
Fattening oxen, 3 period	25.0	2.7	14.8	0.60	18.10	1: 6.0
Fattening sheep, 1 period	26.0	3.0	15.2	0.50	18.70	1: 5.5
Fattening sheep, 2 period	25.0	3.5	14.4	0.60	18.50	1: 4.5
Fattening swine, 1 period	36.0	5.0	27.5		32.50	1: 5.5
Fattening swine, 2 period	31.0	4.0	24.0		28.00	1: 6.0
Fattening swine, 3 period	23.5	2.7	17.5		20.20	1: 6.5
GROWING CATTLE.						
Age Months. — Average live weight per head.						
2—3 — 150 lbs	22.0	4.0	13.8	2.0	19.8	1: 4.7
3—6 — 300 lbs	23.4	3.2	13.5	1.0	17.7	1: 5.0
6—12 — 500 lbs	24.0	2.5	13.5	0.6	16.6	1: 6.0
12—18 — 700 lbs	24.0	2.0	13.0	0.4	15.4	1: 7.0
18—24 — 850 lbs	24.0	1.6	12.0	0.3	13.9	1: 8.0
GROWING SHEEP.						
5—6 — 56 lbs	28.0	3.2	15.6	0.8	19.6	1: 5.5
6—8 — 68 lbs	25.0	2.7	13.3	0.6	16.6	1: 5.5
8—11 — 76 lbs	23.0	2.1	11.4	0.5	14.0	1: 6.0
11—15 — 82 lbs	22.5	1.7	10.9	0.4	13.0	1: 7.0
15—20 — 86 lbs	22.0	1.4	10.4	0.3	12.1	1: 8.0
GROWING SWINE.—Fattening.						
2—3 — 50 lbs	42.0	7.5	30.0		37.5	1: 4.0
3—5 — 100 lbs	34.0	5.0	25.0		30.0	1: 5.0
5—6 — 125*	31.5	4.3	23.7		28.0	1: 5.5
6—8 — 170*	27.0	3.4	20.4		23.8	1: 6.0
8—12 — 250*	21.0	2.5	16.2		18.7	1: 6.5

* Substituted by Americans for the German weights 224, 270 and 350 lbs.

TABLE I.—B. POUNDS PER DAY AND PER HEAD.

Age. Months.	Average live weight per head.	Total dry organic matter.	Digestible Constituents of the Fodder. Albuminoids and Amides, (Proteine.)	Total carbohydrates, (from fibre and non-nitrogenous extract matter.)	Fat.	Amount of nutritive matter.	Nutritive ratio.
Growing Cattle.							
2– 3	150 lbs..........	3.3	0.6	2.1	0.30	3.00	1: 4.7
3– 6	300 lbs..........	7.0	1.0	4 1	0.30	5.40	1: 5 0
6–12	500 lbs..........	12 0	1.3	6.8	0.30	8 40	1: 6.0
12–18	700 lbs..........	16.8	1.4	9.1	0.28	10.78	1: 7.0
18–24	850 lbs..........	20.4	1.4	10.3	0.26	11.96	1: 8.0
Growing Sheep.							
5– 6	56 lbs..........	1.6	0.18	0.87	0.045	1.095	1: 5.5
6– 8	68 lbs..........	1.7	0.17	0.85	0.040	1.060	1: 5.5
8–11	76 lbs..........	1.7	0.16	0.85	0.037	1.047	1: 6 0
11–15	82 lbs..........	1.8	0.14	0.89	0.032	1.062	1: 7.0
15–20	86 lbs..........	1.9	0.12	0.88	0.025	1.025	1: 8.0
Growing Swine.—Fattening.							
2– 3	50 lbs..........	2.1	0 38	1.50		1.88	1: 4.0
3– 5	100 lbs..........	3.4	0.50	2.50		3 00	1: 5.0
5– 6	125[1] ".........	3.9	0.54	2.96		3.50	1: 5.5
6– 8	170[1] ".........	4.6	0.58	3.47		4.05	1: 6 0
8–12	250[1] ".........	5.2	0.62	4.05		4.67	1: 6.5

Table II. is a compilation made by Jenkins,[2] of analyses of American fodders, showing their minimum, maximum and average composition.

Thus giving the range in composition it enables everyone to exercise his own judgment as to whether the fodder immediately under consideration is of inferior, medium or superior quality, and to estimate from this table its probable composition.

In Massachusetts at least the term "meadow hay" is often improperly used for "bog-meadow," "swale," or "swamp hay" as here used, reference is made to hay from our better upland grasses.

[1] Substituted by Americans for the German weights 224, 270 and 350 lbs.

[2] Annual report of the Connecticut Agricultural Experiment Station for 1887, p. 183.

TABLE II.—COMPOSITION OF AMERICAN FEEDING STUFFS.

NAME.	No. of Analyses.	Total Dry Matter.			Proteine.			Crude Fat.			Non-nitrogenous Extract Matter.			Crude Fibre.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max	Aver.	
GREEN FODDER.																	
Maize Fodder	48	7.1	30 9	19.02	.6	3.0	1.63	.1	.9	.41	3 2	19.7	10.62	1.9	11.4	5.23	1.13
Maize Fodder Ensilaged	57	13.0	28.4	19.48	.7	2.8	1.49	.2	1.8	.68	5 1	18.3	10.26	3.0	10.0	5.68	1.31
Sorghum	7	13.6	28 4	21.66	.9	1 4	1.10	.2	.5	.36	5.3	27.0	13.08	4.7	8.5	6.25	.87
Sorghum, Ensilaged	5	22.0	28.1	24.17	.6	.9	.75	.1	.4	.28	13.8	19.0	15.82	5 9	6.8	6.28	1.04
Rye Fodder	6	21.9	25.3	24.72	2.3	3.0	2.61	.2	.7	.56	4 9	12.4	6.94	4.9	14.9	12.73	1.88
Rye Fodder, Ensilaged	1	...	...	19.25	...	...	2.42	...	...	.27	...	...	9.18	...	...	5.76	1.62
Oat Fodder	2	21.4	28 8	25.10	1.5	2.0	1.77	.4	.7	.57	10.8	14 6	12.70	7.1	9.5	8.27	1.79
Clover	1	...	...	26.67	...	...	4.09	...	...	.69	...	...	11.61	...	...	8.12	2 16
Clover, Ensilaged	3	21.5	27.4	28.73	3.0	3.8	3.34	.9	1.1	1.02	8.1	11 4	10.21	5.1	8.6	6.66	2.50
Cow Pea Vines (green and succulent	2	14 0	17.9	15.93	3.0	3.3	3.12	.6	.6	.60	5.3	8.5	6.90	2.9	4.1	3.48	1.83
Beet Leaves	1	...	...	11.16	...	...	2.74	...	...	.60	...	...	2.49	...	...	2.50	2.83
Carrot Leaves	1	...	...	16.70	...	...	4.26	...	...	.86	...	...	5.99	...	...	2.25	3.34
Cabbage Leaves	1	...	...	12.39	...	...	1.96	...	...	.93	...	...	4.52	...	...	1.59	4.16
HAY AND DRY COARSE FODDER.																	
Clover Hay	33	78.2	93.9	88.63	8 9	20.8	12.55	1.5	4.3	2.44	35.0	49 0	40.55	15 6	35.7	26.86	6.23
Hay containing much Clover	10	85 5	89 8	86.68	6 3	14.4	10.33	1.5	3.1	2.52	31.8	45 2	40.46	19.7	35.1	28.07	5 30
White Clover Hay	2	91.4	92 9	92.12	14.1	20.0	17.08	2.1	5.8	3.95	38 2	40.6	39.38	20.3	27.3	23.75	8.00
Alsike Clover Hay	4	91.6	94.8	92.63	11.4	16.1	13.50	1.6	4.2	2.35	36 5	43.5	40.86	27.7	29 5	28.61	7 31
Lucerne Hay (Alfalfa)	3	92.5	94.4	93.52	15.0	18.6	17.04	1.8	2.4	2.05	35.5	39.2	37.12	26.2	33.0	30.21	7.10
Timothy Hay (Phleum pratense)	53	84.5	92.9	89.76	4 2	9.6	6.06	1.0	3.4	2.12	39.2	58 5	47.10	22.7	38.5	30.37	4 11
Red Top Hay (Agrostis vulgaris)	1	...	...	90.16	...	...	7.25	...	...	1.95	...	...	46.52	...	...	27.45	6.99
Timothy and Red Top	10	85.7	91.8	87.64	4.8	9 0	6.52	1.5	2.7	2.00	38 5	48.9	44.15	24.7	38 4	30.17	4.80
Orchard Grass Hay (Dactylis glomerata)	4	88.2	93.5	91.87	3 6	8.2	6.33	1.4	2.4	1.93	33.5	48 6	44.45	29.7	38.3	33.81	5 35
Hungarian Grass Hay	13	91.0	95.2	92.85	5 0	12.3	7.22	1.5	3 5	2.14	44.4	53.0	49.41	23.6	31.3	28.25	5.83
Barley Hay (seed in milk)	1	...	...	89.75	...	...	9.21	...	...	2.47	...	...	47.49	...	...	26.14	4.44
Oat Hay	3	86.3	91 3	89.32	7.8	9.9	8.53	2.1	3.1	2.52	36 2	48.0	41.93	25.1	33.6	29.92	6.42
High Meadow Hay	2	88.7	89.4	89.02	6.8	8.3	7.57	2.0	2 5	2.25	46.9	47 5	47.19	24.3	25.2	25.78	6 23

TABLE II COMPOSITION OF AMERICAN FEEDING STUFFS.—Continued.

NAME.	No. of Analyses.	Total Dry Matter.			Proteine.			Crude Fat.			Non Nitrogenous Extract Matter.			Crude Fibre.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
Hay from mixed meadow grass	9	81.0	87.0	84.52	4.9	7.9	6.24	1.4	2.7	2.05	34.4	47.3	40.48	28.7	35.9	31.09	4.71
Low Meadow Hay	10	85.5	93.6	89.50	4.6	10.4	7.70	.7	3.6	2.20	39.8	55.2	48.60	21.4	40.0	30.20	5.80
Hay from salt marsh grasses	13	81.4	92.8	89.89	4.0	7.8	5.69	1.6	3.1	2.31	34.1	54.8	44.10	25.1	37.9	30.51	7.28
Baled Hay, extra fine	1	....	..	84.05	....	...	6.20	...	...	2.19	....	..	45.13	...	..	26.60	3.93
Maize Fodder, field cured	4	60.6	77.1	65.02	3.8	4.6	4.23	.6	1.6	1.08	30.5	40.8	33.79	18.7	24.7	21.27	4.65
Maize Stover, field cured	9	63.5	88.8	77.17	3.8	8.3	5.38	1.1	1.9	1.45	35.8	46.2	40.30	19.1	29.5	25.18	4.86
Maize Stover, dried	11	87.0	92.4	90.43	3.4	8.5	5.02	.8	1.5	1.10	45.3	52.9	49.17	26.6	33.6	29.92	5.23
Buckwheat Straw	3	89.6	91.0	90.09	3.3	7.8	5.15	.7	1.7	1.26	32.1	38.9	35.16	37.2	46.8	42.98	5.54
Oat Straw	12	87.5	93.5	91.26	2.3	6.9	3.82	1.0	3.2	2.22	26.4	51.4	38.89	29.5	56.0	41.52	4.81
Rye Straw	8	87.5	93.7	92.24	2.2	6.9	3.46	1.0	2.7	1.40	35.7	52.9	38.35	34.2	43.8	45.25	3.78
Wheat Straw	6	82.1	93.5	91.22	2.9	5.0	3.45	.8	1.8	1.29	31.0	50.6	37.38	34.3	42.7	44.99	4.16
Cow-pea Vines	6	86.0	90.7	85.95	13.6	19.8	15.68	1.1	4.1	2.87	34.9	46.4	42.17	17.2	23.7	19.80	8.41
Roots, Bulbs, Tubers and other Vegetables and Fruit.																	
Beets, red	2	10.5	12.3	11.43	1.5	1.7	1.60	.2	.2	.18	7.2	7.6	7.40	.6	1.7	.12	1.08
Beets, sugar	8	9.2	16.4	13.03	1.7	2.9	2.01	.1	.2	.10	5.7	12.0	9.15	.7	1.1	.87	.90
Mangolds	6	5.6	11.7	8.68	1.0	1.9	1.52	....	.5	.16	2.4	8.4	5.00	.8	1.0	.84	1.16
Ruta Bagas	1	...	....	12.92	...	....	1.15	...	....	.09	...	....	9.11	....	....	1.16	1.41
Turnips	2	7.6	8.2	7.92	.8	1.3	1.02	.1	.2	.18	5.8	4.3	5.03	.8	1.2	1.01	.68
Carrots	6	8.9	13.5	11.70	.9	2.0	1.16	.2	.7	.42	5.1	10.4	7.68	1.0	2.8	1.38	1.06
Onions	6	6.5	18.4	12.46	.8	2.3	1.41	.2	.4	.26	3.8	14.1	9.53	.6	.8	.69	.56
Potatoes	7	19.4	24.1	21.90	1.1	3.0	2.19	....	.2	.10	15.3	20.0	18.19	.3	.9	.54	.88
Sweet Potatoes	5	26.6	34.0	29.87	.5	3.6	1.55	.3	.6	.38	18.0	29.7	25.09	.6	2.5	1.36	.99
Cabbage	2	6.5	10.2	8.28	1.8	2.0	1.95	.2	.5	.33	2.0	3.5	2.75	1.4	3.0	2.21	1.04
Squash	2	4.8	5.4	5.12	.6	.6	.66	.2	.3	.28	2.9	3.5	3.24	.5	.5	.54	.40
Pumpkin	1	..	...	7.73	..	...	1.11	....	...	.16	....	....	4.34	....	....	1.49	.63
Apples	5	15.9	22.7	18.22	.2	1.2	.69	.3	.6	.41	12.6	20.0	15.31	.9	2.9	1.49	.32

TABLE II.—COMPOSITION OF AMERICAN FEEDING STUFFS.—Continued

NAME.	No. of Analyses.	Total Dry Matter.			Proteine.			Crude Fat.			Non-nitrogenous Extract Matter.			Crude Fibre.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
GRAIN AND OTHER SEEDS.																	
Barley	9	87 4	92 7	89.08	8.6	15.7	12.39	1.5	3.1	1.86	66.7	73.9	69.88	1.2	4.1	2.57	2.38
Buckwheat	8	85.1	89 1	87.40	8.6	11.1	10.00	2 2	2.4	2.25	62.6	65 4	64.50	7.8	9.4	8.70	2 00
Oats (raised in Conn.)	7	86.5	90 7	89.06	8 0	10.1	9.32	4.7	5.8	5.29	59.0	64.2	61.55	8.9	12.9	9.95	2.95
Oats	25	86 5	91.1	89.06	8 0	14.4	11.38	3.4	5.8	4.81	50 8	66.9	60.05	1.5	19.4	9.85	2.97
Rye	6	86.8	91.8	88.40	9.5	12.1	10.60	1.4	2.1	1.70	70.7	73 9	72.60	1.4	2.1	1.60	1.90
Wheat, winter	242	83.8	92.9	89.48	8.3	16.6	11.73	1.3	3.9	2.11	68 1	76.6	72.01	.4	2.9	1.77	1 86
Wheat, spring	13	86 6	91.9	89.63	8.1	15.4	12.51	1.8	2.5	2.20	66 1	78.6	71.19	1 8	2 8	1.82	1.91
Wheat, unclassified	55	87.6	90.9	89.81	9.8	14 7	11.96	1.6	2.8	2.10	68.5	74.7	71.50	1 2	3.1	1.92	1.83
Wheat, average of all analyses	310	83.8	92 9	89.46	8.1	16 6	11.80	1.3	3.9	2.11	66.1	78 7	71.89	.4	3.1	1.80	1.86
Maize, dent	80	85.9	93.7	89.91	7 5	12.1	10.33	3.8	6.9	5.10	66.2	75 7	70.66	1.2	4.8	2.28	1 54
Maize, flint	70	80 4	93.4	88.93	7.0	13 7	10.57	3.4	7.1	4.96	65.0	74 6	70.31	.7	2 9	1.65	1 44
Maize, sweet	26	89.1	94.0	91.18	9.5	15.3	11.62	3.8	11.9	8.14	61.8	72.4	66.70	1.5	5.2	2.80	1.92
Maize, "Western Corn"	3	79.3	83 6	80.90	7.8	8.6	8.30	3.6	3 9	3.70	64.9	68.2	66.00	1.7	1.8	1.75	1.20
Maize, average of all analyses	192	79.3	94 0	89.49	7.0	15 3	10.55	3.4	11.9	5.45	61.8	75.7	69.85	.7	5.2	2.09	1 54
Sorghum Seed	9	83 2	90 7	87.48	7.6	11 2	8.88	2.1	4 6	3.65	66.8	73.6	71.26	1.4	3.2	1.88	1.80
Cotton Seed, hulls and kernels	1	....	....	92.28	..	..	15.72	....	....	18.56	...	...	29.09	...	...	25.73	3.16
Cow Pea	5	79.2	89.9	85.21	19.3	23 0	20.77	1.3	1.6	1.43	48 1	61 9	55.75	3.8	5.0	4.06	3.20
Soja Bean	4	86.0	93 9	91.53	34.6	40.2	37.22	12.3	19.0	16.52	26.2	30.5	28.21	3.7	5.0	5.12	4.46
FLOUR AND MEAL.																	
Barley Meal	3	83.8	86.9	84.90	8 8	13.9	11.80	.7	2 2	1.70	....	...	70.90	..	...	.10	50
Buckwheat Flour	4	82 4	87.2	85.46	4.2	8.1	6.89	.7	1.8	1.44	71.1	79 4	75.79	.2	.5	.34	1 00
Oat Meal	6	91.1	93.8	92.15	12 9	16 2	14.66	6.1	8.8	7.06	66 6	68 9	67.57	6	1.2	.86	2 00
Rye Flour	4	86.4	87 7	86.90	6.0	7 1	6.65	.8	.9	.84	77.6	79.1	78.28	.4	.5	.41	.72
*Wheat Flour, from winter wheat	1	...	..	87.04	..	...	8.56	....	....	1.19			76.59			.17	.5

3

*The average of 18 analyses, most of them incomplete, is: Total Dry Matter, 89.63; Ash, 64.; Proteine, 10.92.

TABLE II.—COMPOSITION OF AMERICAN FEEDING STUFFS.—Continued.

NAME.	No. of Analyses.	Total Dry Matter.			Proteine.			Crude Fat.			Non-nitrogenous Extract Matter.			Crude Fibre.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
†Wheat Flour, from spring wheat	6	86.5	89.7	87.68	8.6	14.1	10.68	.6	2.0	1.11	68.3	78.1	75.00	..	1.2	.22	.64
Wheat Flour, unclassified	21	86.4	88.8	87.52	9.7	13.8	11.25	.8	1.9	1.16	69.5	76.9	74.83	1	1.0	.25	.58
Wheat Flour, average of all varieties	25	86 4	89.7	87.44	8.6	14.1	11.28	.6	2.0	1.20	68.3	78.1	74.18	.0	1.2	.27	56
Graham Flour	3	86.3	87 9	86.90	11.3	12.4	11.70	1 5	1.9	1.70	69 8	70 0	69.80	1.8	2.1	1.90	1.80
Maize Meal	56	74.5	92.0	84.15	7.1	10.3	9.16	2.2	5 1	3.81	57.0	74.0	67.84	.5	2.8	1.80	1.46
Hominy	2	86.4	86.6	86.50	8.1	8.4	8.25	.4	.5	.44	77 1	77 2	77.12	.3	.8	.32	.38
Sorghum Meal, mostly decorticated	1	..	..	86.84	..	...	8.25	...	...	3.85	..	..	71.27	...	..	1.88	1.59
Pea Meal	2	87.0	91.2	89.54	19.1	21.4	10.23	.9	1.5	1.19	50.2	52 0	51.09	11.1	17.7	14.33	2.64
By-Products and Refuse.																	
Apple Pomace	7	22.1	27.4	22.94	1.0	1.7	1.40	.6	2 0	1.36	12.6	17 6	15.63	2.0	5 9	4.01	.54
Brewers' Grains, wet from brewery	15	20.6	31.4	24.99	4.3	7.7	5.57	.8	2.9	1.68	10 1	15.7	12.86	3.0	5 6	3.87	1 01
Brewers' Grains, dried	3	88.1	93.8	91.81	19 2	20.2	19.89	4 2	6.5	5.56	46.1	56 8	51.75	10.2	11 6	11.01	3.58
Brewers' Grains, kiln-dried	1	....	...	97.43	...	..	20.30	....	...	6.40	....	..	54.89	...	..	11.79	3.97
Brewers' Grains, from Silo	3	26.1	33.2	30.18	5.8	7.1	6.64	1.8	2.5	2.11	13.6	16.8	15.28	3.9	5.4	4.64	1.21
Brewers' Swill	1	...	..	5.70	..	...	1.90	...	..	.80	...	.	2.00	...	...	.70	.30
Malt Sprouts	3	88.0	92.7	89.72	21.0	25.9	22.95	1.1	2.9	1.79	45.4	50.3	48.60	9.3	11.9	10.72	5.67
Cotton Seed Meal	29	81.5	94.2	91.68	23.3	50 8	42.39	10.2	18.0	13.37	12 7	38.6	22.97	2 7	11.7	5.69	7.26
Linseed Meal, old process	12	87.4	93.9	90.97	27.7	38.2	32.33	5.1	11 6	8.24	30.8	41.9	35.22	7.1	13 3	9.31	5.87
Linseed Meal, new process	12	86 6	93.2	89.25	27.1	37.1	32.85	1.3	4.4	3.08	35 2	48.0	38.29	7.6	14 0	9.46	5.57
Linseed Meal, oil not removed	1	...	..	91.67	..	....	22.97	....	..	30.26	....	....	25.48	....	.	9.60	3.36
Palm Nut Meal	3	89.1	93.8	91.71	13.5	16 0	14.39	6 4	18.7	13.30	33.8	41.6	38.88	18 7	23 9	21.40	3.74
Rye Bran	6	86.3	91.8	88.51	11.5	16 8	15.28	1.8	4 9	2.46	59.8	67.6	63.66	2.5	4 1	3.52	3.59
Wheat Bran	63	84.2	91.8	87.72	7 5	16 9	15.07	1.5	5.9	3.78	50.0	67.6	54.26	2.4	17.8	8.71	5 70
Wheat Middlings	27	84.0	91.5	88.00	10.1	19.2	15.17	1.3	12 7	4.01	53.0	70 9	60.99	2.1	5 9	4.57	3.26
Wheat Shorts	8	84.5	89.0	87.26	11.1	16.1	13.83	2 5	5.3	4.14	53.3	67.0	57.59	5 8	10.5	7.45	4.25

† The average of 16 analyses, most of them incomplete, is: Total Dry Matter, 88.55; Ash, .60; Proteine, 11.63.

TABLE II.—COMPOSITION OF AMERICAN FEEDING STUFFS.—Continued.

NAME.	No. of Analyses.	Total Dry Matter.			Proteine.			Crude Fat.			Non-nitrogenous Extract Matter.			Crude Fibre.			Ash.
		Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	
"Hominy Chips," "Hominy Feed," "Baltimore Meal," "White Meal"	11	86.5	91.9	88.86	7.9	11.2	9.85	4.6	11.2	8.48	61.0	71.1	64.49	2.5	4.8	3.59	2.50
Gluten Meal	11	88.3	92.7	90.61	25.0	35.0	29.58	4.2	8.7	6.31	44.7	58.5	52.64	.7	3.8	1.34	.74
Maize Cob	13	85.6	92.8	90.67	1.2	3.7	2.50	.1	.9	.45	45.3	66.4	55.99	28.2	38.2	30.36	1.33
"Starch Feed," refuse from starch manufacture	8	27.8	37.7	34.34	3.6	7.7	5.73	1.3	4.3	3.02	18.7	28.9	22.21	1.6	4.3	3.17	.21
"Sugar Feed," kiln dried refuse from glucose manufacture	2	89.6	93.4	91.50	13.1	13.5	13.30	5.9	11.2	8.60	54.9	61.4	58.10	8.4	10.7	9.50	2.00
Sorghum Bagasse	4	11.3	16.6	14.50	.6	.7	.65	...	...	...	...	...	10.20	2.8	3.3	3.10	.60

Table III. shows the coefficient of digestibility, *i. e.* the number of pounds of proteine, fat and carbohydrates in 100, actually digested by animals. This table as seen by the foot notes is of German origin.

Where possible the minimum average and maximum results are given, enabling one, according to the quality of the crop, to modify if desired, the numbers expressing the average digestibility. The digestibility of crude fibre is given in every case, though according to the latest investigations it has no apparent value for horses. (See pages 39–40.) In computing feeding rations for horses it may then be ignored. It is to be greatly hoped that we may soon have data enough for the compounding of complete tables of digestion coefficients as found for our own fodders, by use of our own animals under our own climatic conditions. Such determinations as have already been made indicate its necessity.

TABLE III.—DIGESTIBILITY OF FEEDING STUFFS[1]—DIGESTION COEFFICIENTS.

Fodders marked (R) were tested with ruminants.[2] Fodders marked (H) were tested with horses. Fodders marked (S) were tested with swine.

KIND OF FODDER.	No. of samples tested.	No. of experiments.	Total Dry Organic Matter.			Proteine.			Crude Fat.			Non-nitrogenous Extract Matter.			Crude Fibre.		
			Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.
Green Fodders.																	
Pasture Grass, (R)	8	6	75	78	77	72	79	75	68	69	66	75	84	78	72	80	75
Meadow Grass, (H)	12	15	43	62	50	54	69	60	10	42	22	49	67	59	33	57	41
Meadow Rowen, (R)	6	30	62	71	64	61	68	62	31	56	46	63	74	66	59	68	64
Pasture Clover, very young, (R)	1	2	...	...	45	...	...	78	...	...	64	...	...	78	...	...	67
Red Clover, before blossoming, (R)	6	15	59	74	66	60	76	66	58	74	64	63	83	73	47	60	53
Lucerne (alfalfa), in bloom, (R)	4	10	55	57	56	67	73	70	29	55	39	61	66	63	37	45	42
Serradella, in bloom, (R)	1	2	...	...	62	...	...	75	...	...	65	...	...	63	...	...	50
Maize, green, (R)	1	1	...	...	70	...	...	73	...	...	75	...	...	67	...	...	72
Sorghum, green, (R)	1	1	...	...	73	...	...	62	...	...	85	...	...	78	...	...	59
*Fodder Beans and Peas, Serradella, Cabbage, Turnip leaves and Parsnip leaves	...	...	...	...	...	...	...	71	...	...	60	...	...	65	...	...	54
*Fodder Rye and Oats, Beet and Carrot leaves, and Buckwheat (before blossoming)	...	...	...	...	...	...	...	60	...	...	50	...	...	60	...	...	40
Hay.																	
Vetch Hay, (R)	1	6	...	...	65	...	...	76	...	...	60	...	...	66	...	...	54
Lupine Hay, in bloom, (R)	1	2	...	...	...	...	...	74	...	...	30	...	...	62	...	...	74
Meadow Hay, (R)	38	104	46	71	62	42	72	62	10	63	52	49	76	64	46	71	57
Meadow Hay, very good, (R)	14	42	56	71	65	57	70	64	31	63	50	58	76	68	55	71	62
Meadow Hay, medium, (R)	24	62	46	69	60	42	72	57	10	63	48	49	73	62	46	66	58

[1] This table was copied from the Landw. Kalender for 1889, as compiled by E. von Wolff; where starred, from Julius Kühn's book "Die Zweckmässigste Ernährung des Rindviehs," 9th edition, 1887.
[2] Cud-chewing animals possessed of compound stomachs like oxen, sheep, etc.

TABLE III. DIGESTIBILITY OF FEEDING STUFFS—DIGESTION COEFFICIENTS. Continued.

KIND OF FODDER.	No. samples tested.	No. of experiments.	Total Dry Organic Matter.			Proteine.			Crude Fat.			Non-nitrogenous Extract Matter.			Crude Fibre.		
			Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.
Meadow Hay, inferior, (R)	7	18	46	59	55	42	56	51	10	57	41	49	61	58	46	61	54
Meadow Hay, very good, (H)	4	6	49	55	41	55	66	62	14	42	20	52	61	57	36	46	42
Meadow Hay, medium, (H)	4	4	48	56	48	55	60	57	19	31	24	49	67	55	33	42	36
Clover Hay, very good, (R)	6	12	58	68	61	55	69	62	44	72	60	67	72	70	39	52	47
Clover Hay, medium, (R)	6	19	54	62	57	48	61	55	35	70	51	58	67	65	39	52	45
Clover Hay, (H)	4	5	49	55	51	51	60	56	28	31	29	61	67	64	35	39	87
Lucerne Hay, very good, (R)	9	28	55	67	60	67	83	74	29	55	39	61	73	66	34	48	48
Roots.																	
Potatoes, (R)	3	28	83	90	88	64	67	65	..	....	.....	89	96	93	....	....	.....
Potatoes, (S)	5	8	....	..	93	...	...	73	..	....	.....	.	....	98	....	....	55
Sugar Beets, (R)	2	28	84	93	89	56	68	62	..	....	.....	95	96	95	....	..	.....
Mangolds, (R)	2	16	87	88	88	66	86	76	...	....	.....	94	96	95	....	....	.....
Turnips, (R)	1	8	....	...	78	....	..	57	....	....	.....	....	....	89	....	....	.....
Grains.																	
Oats, (R)	6	31	62	74	68	68	86	77	75	97	82	67	79	74	....	26	17
Oats, (H)	8	22	62	71	67	68	89	79	60	78	70	72	76	74	1	38	20
Barley, (H)	1	1	....	....	87	...	...	80		..	42	....	..	87	..	....	100
Barley Meal, (S)	4	8	82	85	88	75	80	78	65	77	68	89	91	90	....	27	12
Maize, (R)	1	2	...	...	89	..	...	79	...	..	85	...	..	91	..	..	62
Whole Maize, (H)	1	1	....	....	91		...	78	.	.	68	.	...	94	..	.	100
Maize Meal, (S)	3	4	90	95	92	84	88	86	76	77	76	93	96	95	19	57	40
Field Beans, (R)	5	18	88	94	89	81	95	88	55	100	87	88	95	92	25	92	72
Field Beans, (H)	1	5	...	....	87	..	....	86	...	....	13	..	...	98	....	....	65
Peas, (R)	1	2	...	....	90	...	..	89	....	..	75		..	98	..	..	66
Peas, (H)	1	1	...	..	80	....	...	83	....	....	9	....		89		...	8
Pea Meal, (S)	5	10	88	95	91	85	90	88	36	67	49	95	99	96	55	89	71

TABLE III.—DIGESTIBILITY OF FEEDING STUFFS—DIGESTION COEFFICIENTS.—Continued.

KIND OF FODDER.	No. samples tested.	No. of experiments.	Total Dry Organic Matter.			Proteins.			Crude Fat.			Non-nitrogenous Extract Matter.			Crude Fibre.		
			Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.
By Products and Refuse.																	
Wheat Bran, fed dry,[1] (R)	5	12	67	78	72	71	89	78	50	80	70	70	82	77	20	39	33
Rye Bran, (S)	1	2	...	...	67	...	...	66	...	...	58	...	...	75	...	...	4
Malt Sprouts, (R)	1	3	...	...	84	...	...	82	...	...	49	...	...	88	...	...	95
Brewer's Grains, (R)	1	2	...	...	63	...	...	73	...	...	84	...	...	64	...	...	39
Rape Meal, oil extracted, (R)	1	1	...	...	68	...	...	84	...	...	...	...	...	85	...	...	...
Rape Cake, (R)	2	7	56	75	66	76	86	81	69	88	79	74	78	76	...	16	8
Linseed Meal, oil extracted, (R)	1	8	...	...	71	...	...	82	...	...	91	...	...	73	...	...	...
Linseed Cake, (R)	2	10	78	83	81	84	87	86	89	91	90	70	91	80	26	62	44
Palm Nut Meal, oil extracted, (R)	2	3	89	93	91	89	100	95	89	100	95	92	96	94	72	92	82
Cotton Seed Cake, decorticated, (R)	1	2	...	...	80	...	...	85	...	...	88	...	...	95	...	...	...
Cotton Seed Cake, not decorticated, (R)	1	4	...	...	50	...	...	73	...	...	91	...	...	46	...	...	23
Cocoanut Cake, (R)	1	2	...	...	78	...	...	76	...	...	100	...	...	81	...	...	62
Cocoanut Cake, (S)	1	2	...	...	80	...	...	74	...	...	83	...	...	89	...	...	60
Flesh Meal, (R)	1	2	...	...	95	...	...	95	...	...	98	...	...	...	...	...	...
Flesh Meal, (S)	1	8	...	...	95	...	...	97	...	...	87	...	...	...	...	...	...
Blood Meal,[2] (R)	1	2	...	...	63	...	...	62	...	...	100	...	...	100	...	...	...
Blood Meal, (S)	1	1	...	...	72	...	...	72	...	...	...	...	...	92	...	...	...
Fish Guano, (R)	1	2	...	...	...	...	...	90	...	...	76	...	...	...	...	...	...
Straw.																	
Wheat Straw, (R)	2	3	45	48	46	8	26	17	27	44	36	37	40	39	52	59	56
Wheat Straw, (H)	1	2	...	...	23	...	...	19	...	...	...	...	...	18	...	...	27
Rye Straw, (R)	2	9	42	51	46	17	25	21	...	...	32	35	38	37	49	70	60

[1] Several experiments have shown it to be better digested when fed dry than when cooked or fed wet.

[2] Very hard and compact.

TABLE III.—DIGESTIBILITY OF FEEDING STUFFS—DIGESTION COEFFICIENTS.—Concluded.

KIND OF FODDER.	No. samples tested.	No. of experiments.	Total Dry Organic Matter.			Protein.			Crude Fat.			Non Nitrogenous Extract Matter.			Crude Fibre.		
			Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.	Min.	Max.	Aver.
Barley Straw, (R)	2	5	51	55	53	17	24	20	41	43	42	51	57	54	55	56	56
Pea Straw, very good, (R)	1	2	....	...	59	...	.....	61	....	.....	46	....	....	64	....	...	52
Oat Straw, (R)	5	9	43	56	50	14	48	35	20	49	35	39	45	45	48	64	57
Field Bean Straw, (R)	2	5	....	...	51	....	.....	49	....	.....	56	....	...	64	....	...	39
Lupine Straw, (R)	1	2	...	....	55	...	.....	37	....	.....	30	....	....	65	....	....	51
Soja Bean Straw, (R)	2	4	...	....	55	....	.....	50	....	.....	60	....	....	66	....	....	38

8

Table IV. shows the number of pounds of digestible proteine, fat, etc., in one hundred pounds of the fodders in their *natural state* of moisture, and is found by use of the figures showing average composition and average digestibility, as follows:

MAIZE FODDER (UNDER GREEN FODDERS).

	Composition. Table II. Lbs.		Coefficient of Digestibility. Table III. Lbs.		Amt. Digested from 100 lbs. of Original Fodder. Table IV. Lbs.
Crude proteine..........	1.63	×	.73	=	1.19
Crude fat..............	.41	×	.75	=	.31
Non-nitrogenous extract matter............	10.62	×	.67	=	7.12
Crude fibre.............	5.23	×	.72	=	3.77

The prices for the valuation of the fodders are the same as used by Cooke.[1]

Since *the real value of a fodder depends upon the relative amount and digestibility of the constituents*, such a valuation brings out more prominently *relative values.* It is more difficult in case of fodders than for fertilizers, to lay down reliable prices for a *commercial* valuation. The actual value to the farmer like the *agricultural value* of a fertilizer depends upon the manner in which it is to be used. If the production of milk is the object, and we have at disposal only mixed hay, maize meal, and corn (maize) stover, with nutritive ratios of 1:12.8, 1:9.2, and 1:19.3 respectively, then wheat bran, cotton seed meal, etc., with ratios of 1:4.4 and 1:1.4, are especially valuable as additions, since the best ratio for milk production lies between these, *i. e.*, 1:5.4 or perhaps a little wider. If we had only alfalfa with a ratio of 1:3.1 and cow pea vines with a ratio of 1:3.3, then corn meal with a ratio of 1:9.2 might be more valuable.

Since occasional changes in the process of manufacture cause a variation in the composition of the by-products so largely used for feeding, selling on a *guaranteed analysis* as is done with fertilizers might prove beneficial to both dealer and farmer.

[1]First Annual Report Vermont State Agricultural Experiment Station, p. 96.

TABLE IV.—DIGESTIBLE PORTION (IN 100 LBS.) OF FODDER.

(R)—As digested by ruminants. (H)—As digested by horses. (S)—As digested by swine.

NAME OF FODDER.	Total dry matter.	Digestible proteine.	Digestible fat.	Digestible Non-nitrogenous extract matter.	Digestible fibre.	Nutritive ratio.	Value per ton.
		Valued at .4⅛ cents per pound.	Valued at .4⅛ cents per pound.	Valued at .9 cents per pound.	Valued at .9 cents per pound.		
GREEN FODDER.							
Maize Fodder, (R)	19.02	1.19	.31	7.12	3.77	1: 9.7	$3 26
Sorghum, (R)	21.66	.68	.31	10.20	3.68	1: 21.6	2 82
Rye Fodder, (R)	24.72	1.57	.28	4.16	5.09	1: 6.3	3 27
Oat Fodder, (R)	25.10	1.06	.29	7.62	8.31	1: 11.0	3 14
Clover, (R)	26.67	2.70	.44	8.48	4.30	1: 5.1	5 02
Cow-pea Vines, green and succulent	15.93	2.22	.36	4.49	1.88	1: 3.3	3 38
Beet Leaves	11.16	1.64	.30	1.49	1.00	1: 2.0	2 13
Carrot Leaves	16.70	2.56	.43	3.59	.90	1: 2.2	3 40
Cabbage Leaves	12.39	.84	.56	2.94	.86	1: 6.2	1 90
HAYS.							
Clover Hay, (R)	88.63	6.90	1.24	26.36	12.09	1: 6.0	13 98
Lucerne Hay, alfalfa, (R)	93.52	12.61	.80	24.50	12.99	1: 3.1	18 36
[1]Timothy, (Phleum pratense), and Red Top, (Agrostis vulgaris), (R)	87.64	4.04	1.04	28.26	17.20	1: 11.9	10 59
Hay, from mixed meadow grasses, (R)	84.52	3.56	.98	25.07	18.03	1: 12.8	11 70
[2]Maize Stover, field cured	77.17	2.15	.44	40.30	....	1: 19.3	9 49
Oat Straw, (R)	91.26	1.34	.78	17.50	23.67	1: 32.2	9 25
Rye Straw, (R)	92.24	.73	.45	14.19	27.15	1: 58.2	8 46
Wheat Straw, (R)	91.22	.59	.46	14.56	25.19	1: 69.3	8 06
ROOTS.							
Sugar Beets, (R)	13.03	1.25	....	8.69	....	1: 7.0	2 64
Mangolds, (R)	8.68	1.16	....	4.75	....	1: 4.1	1 87

[1] Digestibility assumed the same as for mixed grasses.
[2] Digestibility as assumed by Goessman, Second Annual Report Mass. State Agricultural Experiment Station, p. 107.

TABLE IV.—DIGESTIBLE PORTION (IN 100 LBS.) OF FODDERS.—CONCLUDED.

NAME OF FODDER.	Total dry matter.	Digestible proteine.	Digestible fat.	Digestible Non-nitrogenous extract matter.	Digestible fibre.	Nutritive ratio.	Value per ton.
		Valued at .4⅛ cents per pound.	Valued at .4⅛ cents per pound.	Valued at .9 cents per pound.	Valued at .9 cents. per pound.		
Turnips, (R)	7.92	.58	....	4.48	....	1: 7.7	$1 31
Potatoes, (R)	12.90	1.42	....	16.92	....	1: 11.9	4 28
Potatoes, (S)	12.90	1.60	....	17.83	.30	1: 11.3	4 65
GRAINS.							
Barley, (H)	89.08	9.91	.78	60 80	2 57	1: 6.6	20 68
Barley, (S)	89 08	9.66	1.26	62.89	.31	1: 6.9	20 84
Oats, (R)	89.06	8.76	3.94	44.44	1.67	1: 6.4	19 31
Maize, average, (R)	89 49	8.33	4.66	63.56	1.30	1: 9.2	22 98
Maize, (H)	89.49	8.44	2.29	60.77	2.09	1: 8.1	20 63
[1]Maize, (S)	89.49	9.07	4.14	66.36	.84	1: 8.6	23 54
Peas, (S)	89.54	9.00	.58	49.05	10.17	1: 6.7	23 49
Peas, (H)	89.54	8.49	.11	45.47	1.15	1: 5.5	15 85
Peas, (R)	89.54	9.10	.89	47.51	9.46	1: 6.5	18 91
BY-PRODUCTS AND REFUSE.							
Brewer's Grains, wet, (R)	24.99	4.07	1 41	8 23	1.51	1: 3.3	6 50
Brewers' Grains, dried, (R)	91.88	14.52	4 67	33.12	4.29	1: 3 4	23 36
Malt Sprouts, (R)	89.72	18.82	.88	42.77	10.18	1: 2 9	26 60
Cotton Seed Meal, decorticated, (R)	91.68	36.03	11.77	21.83	....	1: 1 4	45 36
Linseed Meal, new process, (R)	89.25	32.85	2.80	27.95	....	1: 1.3	35 93
Linseed Meal, old process, (R)	90.97	27.80	7.42	28.18	4.10	1: 1.8	26 83
Rye Bran, (S)	88.51	10.08	1.43	47.75	.14	1: 5.1	18 61
Wheat Bran, fed dry, (R)	87.72	11.75	2.65	41.78	2.87	1: 4.4	20 52

[1] Since for feeding swine whole maize and maize meal have been found equally valuable, the digestibility has been assumed the same.

Table V. is copied from the First Annual Report of the Vermont State Agricultural Experiment Station, 1887, as compiled by Cooke. It gives, as seen, the number of pounds of potash, phosphoric acid, and nitrogen contained in one ton of the various fodder articles, when in their natural state of dryness.

Since only *averages* are given, we get from the table no definite idea of the variations which would otherwise show themselves. The composition of plants is known to vary widely according to the nature of the soil and the method of manuring. Immature plants given here under the head of "green fodders" vary largely in the ash constituents as affected by the amount of water in the plant. The table serves its chief purpose here however, in calling attention to the general difference in composition between different families, and in many cases individuals of the same family of plants.

Of the fertilizing constituents of the fodder, 80 per cent. may be assumed to remain in the liquid and solid excrement, the major portion however in the former.

In the case of fattening grown animals practically the whole amount is recovered in the feces.

In feeding a "maintenance ration" *i. e.* just enough to support life, the animal becomes a factory turning out what enters and changing the grain and hay into stable manure, without loss of fertilizing value or gain to the animal.

TABLE V.—FERTILIZING VALUE OF FODDERS.

Nitrogen valued at 17 cents; phosphoric acid at 6 cents, and potash at 4½ cents per pound.

SUBSTANCE.	Nitrogen per ton.	Phosphoric acid per ton.	Potash per ton.	Valuation per ton.
GREEN FODDER.	Lbs.	Lbs.	Lbs.	
Alfalfa, (Lucerne)	14.0	3.0	9.0	$2 94
Clover, Red	11.7	2.6	11.1	2 62
Clover, Swedish, (Alsike)	10.4	2.0	7.0	2 19
Clover, White	10.0	4.0	4.8	2 14
Maize Fodder, (Indian corn)	4.8	2.2	7.8	1 28
Cow Pea Vines	7.2	2.7	6.0	1 64
Horse Bean, in blossom	8.2	1.6	7.0	1 79
Hungarian Millet	10 6	2.6	17.2	2 69
Meadow Grass	9.6	3 0	12.0	2 32
Oats, unripe	6.6	3.1	13.6	1 89
Rye Fodder	9.5	4.8	12.6	2 44
Serradella	8.2	2.8	8.5	1 92
Sorghum	4.0	1.1	3.7	1 50
Timothy	10.8	4.6	12.2	2 63
Vetches, unripe	9.8	4.0	13.2	2 47
Vetch and oats	5.0	1.9	15.8	1 64
White Lupine	8.8	1.0	5.0	1 77
Young Grass	11.2	4.4	23.2	3 15
ENSILAGE.				
Maize, (Indian Corn)	6.0	2.5	6.8	1 46
Sorghum	2.4	1.0	3.8	0 63
HAY AND COARSE DRY FODDER.				
Alfalfa, (Lucerne)	39 3	9.5	35.6	8 76
Alsike Clover	47.3	16.0	43.5	10 85
Barley Straw	10.0	4 0	19.4	2 77
Bean Straw	20.0	8.2	51.8	6 09
Buckwheat Straw	12.4	12.3	42.2	4 64
Clover Hay	36.6	13.2	44.0	8 88
Clover, Red, in blossom	39.4	11.2	39.0	9 03
Clover, Red, ripe	30.0	7.0	24.4	6 56
Clover, White	47.6	17.0	21.2	10 01
Maize Stover, (Indian Corn stalks)	16.8	8.2	29.4	4 60
Cow Pea Vines	50.2	8.2	28.0	10 22
Maize Fodder, (Fodder corn, Indian)	13.2	3.9	7.5	2 80
Hay	25.0	9.3	41.7	6 58
Hay, fully ripe	24.0	5.8	10.0	4 86
Meadow Hay	34.6	8.1	32.8	7 76
Oats, unripe	29.4	10.2	48.2	7 66
Oat straw	10.4	5.3	26.7	3 23
Orchard Grass, (Dactylis glomerata)	26.2	8.3	37.6	6 55
Peas, unripe	45.6	19.4	59.2	11 43
Red Top, (Agrostis vulgaris)	22.9	7.2	20.4	5 19
Rowen	38 6	7.3	57.2	9 43
Rye Straw	14.6	7.4	20 2	3 78
Serradella	50.8	18.0	52.0	11.92

TABLE V.—FERTILIZING VALUE OF FODDERS.—*Continued.*

SUBSTANCE.	Nitrogen per ton.	Phosphoric acid per ton.	Potash per ton.	Valuation per ton.
	Lbs.	Lbs.	Lbs.	
Sorghum Leaves	30.4	10.4	22.4	$6 74
Timothy Hay, (Phleum pratense)	25.1	10.0	31.6	6 21
Vetches, unripe	45.4	18.8	61.8	11 47
Wheat Chaff	13.6	19.0	11.2	3 93
Wheat Straw	12.8	4.7	14.5	3 07
GRAINS, FRUITS AND VEGETABLES.				
Apples	2.7	0.2	3.9	0 64
Barley	36.8	14.5	8.7	7 50
Beans	82.0	23.2	24.0	16 35
Beets, Sugar	5.6	0.6	3.6	1 14
Broom Corn Seed	34.2	14.4	10.4	7 12
Buckwheat	30.4	12.2	8.0	6 24
Carrot	3.3	2.0	7.7	1 01
Maize, kernels, (Indian corn)	35.2	13.6	8.0	7 14
Maize and Oats, equal parts	32.2	14.4	8.6	6 70
Maize and Oats, ¾ maize and ¼ oats	28.0	13.0	8.4	5 90
Cotton Seed Kernels	99.6	34.4	22.8	19 96
Cow Pea Seed	66.4	20.2	20.2	13 36
Flaxseed	72.0	30.8	24.6	15 14
Mangolds	4.6	0.9	8.4	1 19
Millet, with husk	46.4	18.2	9.4	9 38
Millet, without husk	40.0	13.2	4.6	7 78
Oats	38.7	14.2	10.3	7 87
Oats, heavy	37.0	15.4	10.4	7 65
Oats, light	33.8	15.6	11.4	7 16
Peas	72.0	17.6	19.6	14 13
Potatoes	6.5	3.4	11.4	1 79
Rye	34.6	16.2	10.7	7 31
Sorghum Seed	30.2	16.2	7.5	6 42
Turnips	3.9	1.4	5.8	0 99
Turnips, Swedes	4.8	1.2	4.0	1 06
Vetch	88.0	15.8	12.6	16 45
Wheat, winter	37.6	19.6	10.6	8 02
Wheat, spring	40.0	17.2	11.2	8 31
Wheat, average	37.8	17.2	10.5	7 91
FLOURS AND MEALS.				
Buckwheat Flour	20.8	9.8	3.1	4 26
Maize Meal, (Indian corn meal)	29.0	12.8	8.0	6 04
Pea Meal	73.3	17.3	19.8	14 34
Rye Flour	33.6	17.0	13.0	7 28
Wheat Flour	39.7	7.7	6.7	7 49
BY-PRODUCTS AND REFUSE.				
Apple Pomace	4.5	0.4	2.7	0 90
Brewers' Grains	17.8	6.2	10.0	3 82
Broom Corn Seed Waste, Stalks	17.4	9.2	37.2	5 09
Buckwheat Bran	57.3	31.3	19.7	12 46

TABLE V.—FERTILIZING VALUE OF FODDERS.—*Concluded.*

SUBSTANCE.	Nitrogen per ton.	Phosphoric acid per ton.	Potash per ton.	Valuation per ton.
	Lbs.	Lbs.	Lbs.	
Cotton Seed Meal, decorticated	120.7	49.6	33.8	$24 94
Cotton Seed Hulls	7.0	1.8	26.4	2 42
Maize Bran, (Indian corn bran)	22.2	9.8	9.4	4 76
Corn (Maize) and Cob Meal	25.9	10.9	8.7	5 43
Corn (Maize) Cob	9.4	2.9	12.8	2 32
Gluten Meal	99.6	8.5	1.1	17 49
Hominy Meal	31.7	21.8	11.1	7 17
Linseed Cake	102.4	37.9	28.9	20 84
Linseed Meal	106.0	38.8	28.2	21 55
Linseed Meal, old process	98.6	....	....	16 76
Linseed Meal, new process	105.4	43.5	30.9	20 91
Malt Sprouts	74.7	31.8	36.0	16 14
Millet Meal	36.6	11.0	4.6	7 08
Rye Bran	47.5	48.1	28.3	12 16
Rye Middlings	35.3	19.2	12.7	7 69
Sugar Beet Cake	36.0	2.0	7.2	6 55
Wheat Bran	49.7	60.7	31.3	13 42
Wheat Middlings	47.0	22.1	13.0	9 87

For convenience in reducing from quarts and bushels to pounds and ounces, the following table copied from Whitcher[1] is given. Occasional tests to see that the weights correspond should nevertheless be made, and, if possible, weighing rather than measuring should be preferred.

WEIGHT OF GRAINS.

	Weight per ½ Bushel. lbs.	oz.	Per Quart. lbs.	oz.
Corn meal	23	8	1	7
Cotton seed meal	25	8	1	9
Shorts	11	4	0	11
Middlings	18	0	1	2
Ground oats	12	0	0	12
Gluten meal	26	0	1	8
Corn and cob meal	22	0	1	6
Cracked corn	28	0	1	12
Whole oats	16	0	1	0

[1] Bulletin No. 4, N. H. Agricultural Experiment Station, Nov. 1888.

Or stated in another way:

1 pound of	corn meal equals	0.7	quarts.
1 "	cotton seed "	0.625	"
1 "	shorts "	1.43	"
1 "	middlings "	0.90	"
1 "	oats "	1.33	"
1 "	gluten meal "	0.617	"
1 "	corn and cob "	0.73	"
1 "	cracked corn "	0.57	"
1 "	whole oats "	1.00	"

Use of the Feeding Standards and General Discussion of Feeding and Feeding Experiments.

The foregoing tables *are not and cannot be absolutely exact.* They are applied however in the feeding of stock in Europe, and their use has proven a money saving operation; we recommend them on the principle that it is better to have a *safe general guide* than no guide at all. The analyses of crops are all American analyses, and as soon as our experiment stations shall have determined the digestibility of our various fodders with the various classes of live stock, other co-efficients of digestibility will be compiled and published.

To attain this end will require the combined effort of several stations for a series of years. A single "respiration apparatus" which is indispensible for settling some of the more complicated feeding problems can only be constructed at a cost of several thousand dollars, and sometimes requires several months to put it in full working order for the carrying out of a single experiment. Two such, at least, were to be in operation this season, one by Prof. G. Kühn, in Mökern Saxony, and one by Prof. Henneberg in Göttingen. In neither England or America is such an apparatus in existence.

In order to illustrate the use of the foregoing tables let us suppose an example in which we have to do with material of *average composition* and *digestibility.* In Table 1. we find how much of the digestible constituents of various kinds are required daily for animals of 1000 lbs. live weight.

To determine the live weight of animals approximately we will

give the rule used by Whitcher[1] who, though not claiming it to be exact, has nevertheless found its results in many cases to compare well with the actual weights. "Ordinary cattle girting 5 ft. will weigh 650 to 750 lbs., according to form and fatness; for each additional inch in girth add 25 lbs. up to 6 ft. and for each inch after 6 ft. add 50 lbs."

Let us suppose the animal in question to be a milch cow weighing 900 lbs., and giving a good quantity of milk and that we have corn (maize) stover, field cured, mixed hay, and clover hay, in the barn, and have purchased as additional fodder, wheat bran and cotton seed meal.

Turning to Table I., we find that for 1000 lbs. live weight are required daily *24 lbs. of dry matter*, 2.5 lbs. of proteine, 12.5 lbs. of carbohydrates (non-nitrogenous extract matter and fibre) and .40 lbs. of fat.

We find then the amount of dry matter required for a 900 lbs. animal as follows:

$$1000 : 24. :: 900 : x = \frac{900 \times 24}{1000} = 21.6 \text{ or } x.$$

Substituting 2.5 in the place of 24, in the above equation, we get the amount of proteine required. Thus we find a 900 lbs. animal to require 21.6 lbs. dry matter, 2.25 lbs. proteine, 11.25 lbs. of carbohydrates and .36 lbs. of fat daily. Referring to table IV. which gives the amounts of digestible constituents in 100 lbs. of original fodder we can now, by moving the decimal point two places to the left, make a table for the fodders in question which will show the amount of digestible matter in one pound of the fodder.

Fodders.	Total Dry. Matter.	Digestible.		
		Proteine.	Carbohydrates.	Fat.
In 1 lb. corn (maize) stover	.7717	.0215	.4030	.0044
" " mixed hay	.8452	.0356	.4310	.0098
" " clover hay	.8863	.0690	.3845	.0124
" " wheat bran	.8772	1175	.4465	.0265
" " cotton seed meal	.9168	.3603	.2183	1171

If we now decide to try 11 lbs. of corn (maize) stover in our mixture then 11 × .7717 = 8.49, or in our 11 lbs. of stover by

[1] Bulletin No. 4, New Hampshire Agricultural Experiment Station, Nov. 1888, p. 17.

use of the above table we find the amount of dry matter present; in the same way 11. × .0215 = .237 lbs. of proteine. In this manner supposing that we have decided, after a careful scrutiny of the foregoing table, to try 2 lbs. of mixed hay, 6 lbs. of clover hay, 2 lbs. of cotton seed meal and 6 lbs. of wheat bran, we derive the following:

Fodders.	Total Dry Matter.	Digestible.		
		Proteine.	Carbo-hydrates.	Fat.
11 lbs. corn (maize) stover	8.49	.237	4.433	.048
2 " mixed hay	1.69	071	.862	.019
6 " clover hay	5.32	.414	2.307	.074
2 " cotton seed meal	1.83	.721	.436	.234
6 " wheat bran	5 26	.705	2.679	.159
In trial ration	22.59	2.148	10.717	.534
In standard German ration	21 60	2.25	11 25	.36

The nutritive ratio of the German ration is 1:5.4. Let us now calculate that of the trial one! Fat .534 lbs. (.534 × 2½) = 1.335 lbs. carbohydrate equivalence; adding now the carbohydrates (1.335 + 10.717) = 12.052 lbs. the sum of the total carbohydrate equivalence; now (12.052 ÷ 2.148) = 5.6 or our nutritive ratio is thus shown to be 1:5.6 or practically that of the German one.

The trial ration contains a little more dry matter, and the slight excess of fat compensates for the lesser amount of carbohydrates, in short it is a close agreement with the standard ration. Some American experimenters seem to have found a wider ratio than 1:5.4 better adapted to their purpose in producing milk and favor a ratio of 1 : 6 to 1 : 7. A very wide departure from the standard however will be at the expense of the quality of the milk produced, besides lowering the value of the manurial by products.

From the above we see that corn (maize) stover with a wide ratio of 1: 19.3 may be so compounded with concentrated fodders having a narrow ratio as to give the best possible ration for producing milk. Had the attempt been made to substitute in place of the wheat bran (with a ratio of 1 : 4.4) and cotton seed meal (with a ratio of 1 : 1.4), corn (maize) meal, with a ratio of 1 : 9.2 the resulting ration must have had a ratio too wide to be fed most economically, and could not have produced the best quality of milk.

One must of course use judgment in selecting the materials for this ration, and so vary the amount of the various materials selected by adding more of a concentrated article here, or deducting some of another with a wider ratio there, as the circumstances of the case may demand. A ratio of 1:1.4 is a very *narrow ratio* as contrasted with 1:19.3 which is termed a *wide ratio.*

We have now seen, then, the value of highly nitrogenous fodders in compounding most of the ordinary rations for our live stock. We have also observed in the table showing fertilizing values of fodders the consequently increased value of the stable manure from stock fed on rich nitrogenous food.

Again, we have observed from our cash account, if we have kept one, or from our low bank account, if we have been so fortunate as to have one, that it costs heavily to buy nitrogenous fertilizers. We have found out perhaps already that it is cheaper to buy nitrogenous foods and feed them to the animal getting a fair return from them in the form of milk, and having the farm-yard manure left for use on the farm, than buying nitrogen directly as a fertilizer. This can only result however where care is taken to save the liquid excrement, since its value far exceeds that of the solid portion. In the previous pages of this bulletin we have already referred incidentally to the fact that a large number of leguminous plants, like peas, beans, lupine, vetch, serradella, horse beans, etc., have the ability to take nitrogen from the free nitrogen of the air.

In spite of the fact that several other experiments pointing in the same direction have also been made, we are specially indebted to Prof. Hellriegel, of Bernburg, Germany, for having so satisfactorily settled the question by so many trustworthy and skillfully planned and executed experiments, that it has already been universally accepted as an undisputed fact. By this work he has not only shown us how we may, by growing and plowing under green leguminous crops, wonderfully enhance the fertility of our soils and procure at no extra expense the atmospheric nitrogen for which we must otherwise have paid 16–17 cents per pound, but he has also shown us that rich nitrogenous fodders, the most costly we have been forced to purchase, may be grown upon our own farm by the extra addition of only potash and phosphoric acid.

If the purchase of concentrated nitrogenous fodder articles for

our stock, as an indirect fertilizer supply has then proved profitable, what may be hoped when these shall come to be grown upon the farm itself?

If "green manuring" has thus become an object, then has it become doubly desirable, when possible, to feed the material first and use it as a fertilizer later.

These are questions which mean dollars and cents and will not fail to attract deserved attention. What is needed now, in this connection is better data in relation to the *digestibility and real feeding value of* our farm products, and their most profitable compounding for the various needs of the farm as found by actual experiments, also a determination of *all the plants* which can avail themselves of the atmospheric nitrogen, and finally a systematic attempt to acclimate and introduce as many of them as may be possible.

For these, among other ends, were the agricultural experiment stations established.

BEE KEEPING.

BULLETIN No. 4.

SAMUEL CUSHMAN.

ITS IMPORTANCE.

Extract from Report of Statistician U. S. Department of Agriculture, June, 1889.

" Every State and Territory reports bees and more or less honey, usually a hive or a few colonies for each farmer rather than extensive apiaries and extensive production.

In some locations, as in portions of New York, Ohio, Tennessee, and California, where existing conditions are particularly favorable, apiculture is more prominent, dominating other industries perhaps in a neighborhood, though very rarely the leading branch of agriculture over any considerable area.

The value of the annual product of honey and wax is not generally realized, they are produced more or less extensively in every section of the country, and the aggregate value is large, much larger than that of other crops of which more notice is usually taken. It almost equals the value of the rice or the hop crop, falls but little short of the buckwheat product, exceeds the value of our cane molasses, and of both maple syrup and sugar.

It largely exceeds the aggregate value of all our vegetable fibers excepting cotton, and in 1879 was half as large as the wine product of the year."

"The latest official record of production by States is the returns of the national census for the year 1879. It made the honey production 25,743,218 pounds and wax 1,105,689 pounds.

This office, after carefully studying all available data of local market values and market prices, estimated the farm value of the honey at 22 cents per pound and the wax at 33 cents, making the aggregate value of apiarian products, at the place of production $6,028,389."

From Report on Experiments in Apiculture, U. S. Agricultural Report, 1885, we extract the following:

"As the economic importance of this industry is more generally realized, a wide spread and growing interest is manifested in this much neglected branch of rural husbandry.

The lack of practical knowledge is the main hindrance now existing in the way of the very general adoption of this pursuit among agriculturists, as nearly all parts of the United States are well adapted to profitable bee keeping."

In 1884, "the estimated annual product (honey) ranges from $15,000,000 to $20,000,000, and the annual product of wax is about $1,000,000 in value."

"Not more than 8 or 10 per cent. of those favorably situated for the cultivation of bees are engaged in the pursuit."

IN RHODE ISLAND.

From the census of Rhode Island, 1885, page 572. "The honey bee industry is deemed worthy of especial notice. According to the returns made in December, 1885, there were then in the State 1,939 hives of bees, valued at $9,944.

These bees produced that year for their proprietors 5,769 dollars worth of honey besides laying in their own store of provisions. In other words, the honey bee product amounted that year to fifty-eight per cent. of the honey bee property. Some swarms made no more honey than was required for their own sustenance while others made large quantities and brought a good income to their owners. How much the failure in one case, and success in the other, resulted from good or bad management is an inquiry worthy of consideration.

All the towns in the State except New Shoreham and Jamestown, kept from 4 to 154 swarms of bees. The success attending this branch of industry appears very different in different towns. The profit is not proportioned to the number of swarms kept.

South Kingstown had 154 swarms, valued at $1,038 whose honey product in money was $692, that is 66.7 per cent. of the valuation of the bees. Warwick had 120 swarms, valued at $1,094 that yielded 1,286 dollars worth of honey, that is 113 per cent. of their valuation. Exeter had 119 swarms, valued at $604, that produced 272 dollars worth of honey, that is 45 per cent. of their valuation. Scituate had 102 swarms, valued at $453, whose honey product in money was $129, that is 28.5 per cent. of their valuation.

These figures and facts are suggestive. They give some idea of apiculture in the four towns that have the largest number of swarms."

The South Kingstown bee keepers estimated their swarms at $6.74 a swarm, those of Warwick at $9.12 per swarm and those of Scituate at $4.44 per swarm.

"In conclusion the hope is expressed that the Rhode Island Bee Keepers' Association, organized in 1886, will be revived and will enter zealously upon the work of producing a reform in this branch of industry."

Though ours is comparatively a small State, few bees are kept, and without question, *scores of tons of nectar yearly go to waste that might be gathered.*

While we have not the vast forests of basswood trees found in some states, or the peculiar clay soil with its wonderful annual growth of white clover for which some regions are famous, and which there makes bee keeping possible as an exclusive business, we have advantages they do not possess, a large population within easy reach, and opportunity to inspire confidence in our product by dealing direct with retailer or consumer.

Few localities here are without willow, maple, pear, peach, cherry, apple and locust trees, as well as a growth of raspberry, sumac, alder, golden rod and wild asters or frost weed, all of which yield much nectar. In some sections there is

AN IMPROVEMENT IN THE YIELD,

due to the planting of basswood trees in private grounds and along roadsides for shade. Nothing in this country equals basswood bloom for honey production.

Alsike clover, now more generally planted on heavy soil, in connection with or in place of red clover, is also gradually increasing our bee pasturage, as well as the farmer's crop of cattle fodder.

Bees may obtain the nectar from alsike bloom, while they are unable to reach that in the blossoms of the first crop of red clover.

Buckwheat, usually a profitable crop aside from honey, may be planted to still increase the supply of bee food, though it does not always yield honey.

The great improvements of the past twenty years in bee hives and methods of management, have opened vast possibilities as yet unappreciated by the many.

BEES ARE POOR PROPERTY

in crude and impractical hives, but in those well adapted to their purpose give a good return for the time and money invested. There are poor seasons as well as good ones, and he who weathers best the former gets the best returns from the latter. With but a few colonies the difference in seasons is less noticeable than where a large number are kept.

THE DEGREE OF SKILL

required to manage a moderate apiary is not greater or more difficult to acquire than that required for successful butter making or gardening. A large proportion of the bees kept in the State are managed on the " let alone " and " brimstone pit " plan; that is, hived in the old fashioned box hive if discovered before the swarm have left for the woods, and in the fall a certain number are " taken up," smothered by the fumes of sulphur burned in a hole in the ground for the sake of their honey. Some of the hives are made to take large boxes in the top which receives the surplus. They are removed at the end of the season, and what is below left for the bees to winter on.

Other bee-keepers, having heard of the advantages of modern hives have invested in them, but from insufficient knowledge have started wrong.

They have a pattern of hive illy adapted to practical work, or have neglected to prepare them properly; combs are built across the frames instead of in them; they cannot be moved, and as a result they are also run on the let alone plan and no more profit is received than by the box hive bee-keeper.

A few have studied the business more, and take the required time. They have

PRACTICAL HIVES EASILY OPENED,

in which the combs are straight and even, allowing of quick examination with little disturbance of the bees.

They unite weak colonies in the fall, feed them if in want of winter stores, and in winter give protection from wind and prevent loss of heat by an outer case with packing, or by comfortable quarters in the cellar.

Extra stores are supplied in spring, and, if needed, a more prolific queen; and by various means extensive breeding induced to get a large army of gatherers and comb builders before the honey harvest.

If no more swarms are wanted, breeding is discouraged during the honey flow, and swarming is prevented by one of several methods; and the large army of workers use up their short lives in storing honey instead of rearing bees. The crop removed, a young queen given in place of the one whose best powers are used, the remaining bees are allowed honey enough for winter, and raise enough young to keep up their strength until spring. This is followed year after year, whether the season be good or poor, so when the harvests come a good crop is insured. On the other plan, a good part die each winter, and generally many are weak in the spring, which is often due to old or unprolific queens.

The season of 1885 was a very good one. Colonies (old swarms) gave, under

MODERN MANAGEMENT,

from 50 to 75 lbs. honey each in a number of places in the State. Had all the hives of bees reported in the census been so managed that season they would have been valued higher, and the product instead of 52 per cent. would have been 100 or 150 per cent. at the least estimate, or more than double the amount received; while the winter losses, often occurring after a good season, from the many small swarms that are unable to live even with plenty of honey, would have been comparatively small.

Probably the knowledge most lacked by many old fashioned bee-keepers, and which most hinders success is, how to bridge over poor seasons, or to feed when there is danger of bees starving, how to keep all colonies supplied with a good queen, and to produce the crop in the neat and attractive shape now demanded by both dealer and consumer. The reasons

WHY SO FEW BEES ARE KEPT

probably are, the fear of stings and the prejudice against bees by neighbors unacquainted with their habits, the erroneous views held by some fruit growers as to the injury done by bees to fruit, and a lack of knowledge of the great good done by bees in fertilizing the blossoms of orchard and garden crops while collecting honey.

We do not hesitate to claim that

THE HONEY AND WAX CROP IS NOT THE MOST VALUABLE RESULT

of bee-keeping, but that the principal value of bees to man is their work of carrying pollen from flower to flower.

That they do this is generally overlooked or the fact when known is undervalued.

Naturalists tell us that honey is nature's bait by which bees are induced to take and distribute the fertilizing material. While pollen is distributed among certain blossoms by both insects and the wind, others are so shaped as to be wholly dependent upon the visits of bees.

"The bee takes to give, honey but a fraction of her labors. Man has timely help that he knows not of."

"INSECTS AND PLANT FERTILIZATION."

(Introduction by the Editor of the "American Agriculturist" to six articles on the above subject, which commenced in that publication, May, 1866.)

"The part played by insects in the fertilization of flowers, *i. e.* in the carrying of the pollen or fertilizing dust from the anther which produces it to the stigma or that part of the pistil designed to receive it, is a subject now receiving much attention at the hands of naturalists.

It not only affords an interesting study to the curious observer, but the fact itself is of importance to the cultivator, as some of our products depend upon the aid of insects for their perfection, and *probably the fruitfulness of many of them is largely influenced by the abundance or scarcity of bees and other honey and pollen seekers.* Prof. Gray of Harvard University, the distinguished botanist, has consented to give us, in a series of articles, his observation upon the relation of insects to plants."

We quote from Prof. Gray's articles as follows:

"This sweet matter which flowers so generously produce is, so far as we know, of no direct use to the plant. That insects, in visiting flowers for honey, accidentally or incidentally aid in fertilization, by carrying pollen from anther to stigma, is familiarly understood."

"We cannot resist the conclusion that the aid of insects is, so to say, counted upon, that the blossoms are furnished with honey in order that they may attract insects."

"Why should insects be called in to do that which, by a little different arrangement, would be done by the flower itself?

"The key to the solution of the riddle he (Charles Darwin) found in the principle, recognized by breeders, that close breeding tended to sterilty and debility, while cross breeding among different individuals of the same species avoids this tendency."

"A bee cannot take the honey from an Iris flower without carrying off on its rough head some pollen from the anthers it must rub against. It cannot well take the honey from the next flower of the sort it flies to without depositing some of this pollen on the stigma as it seeks its feeding place." Speaking of orchids, he says: "To

cross the flower of the species is plainly an object of the whole contrivance, and an admirable contrivance it is, by which winged insects are solicited to do the work for sedentary flowers.

"Most of our common, brightly colored blossoms and many that are not at all showy, plainly reveal on inspection their adaptation to cross fertilization by the aid of insects."

"We need not multiply examples. Every garden and every field offers equally good examples—lessons which anybody may read and understand if he will only open his eyes."

"Are all flowers then, it may be asked, aided by insects in the essential business of forming seeds? By no means. In many cases the transport of pollen is left to the winds. Such flowers produce no honey, nor anything attractive to insects, and such flowers, we may add, have no showy corolla. So we may conclude that corollas, or bright colors in any part of the blossom, and also fragrance, are given to plants in order that they may attract insects and be aided by them; an aid which many of them are absolutely dependent on."

"Pines, spruces and the like, are left to the wind to fertilize."

"Grasses and grains also depend upon the wind and have accordingly a vast excess of pollen."

"No plant is known in which at least an occasional cross breeding is not provided for." . . "The pollen is powerless or nearly so, upon the stigma of the same flower, but is efficient upon the stigma of neighboring flowers; and that breeding in and in, which seemed unavoidable from the structure of the blossom, is here prevented only by the differentiation of the pollen and stigma."

The following is from Silliman's Journal, 1862: "We all know how essential plants, and especially their flowers, are to the existence of the multitudinous swarms and tribes of insects, but it is hardly understood that the benefit is reciprocal—that in the long run, insects are also essential to the continued existence of many, if not of most species."—*Prof. Asa Gray.*

"In by far the greater number of flowering plants we find both the male and female element in the same flower, or, in other words, such plants are hermaphrodites. One would naturally suppose that there could be but one object in thus placing the sexual elements in such immediate juxtaposition, namely, that each pistil

might be fertilized by its own pollen or male element. Late researches have, however, made it evident that often among plants, the nuptials cannot be celebrated without the intervention of a third party, to act as marriage priest; and that the office of this third party is to unite the representatives of different households. To be specific, seed capsules are most productive when their ovules are fertilized by pollen from another plant or flower of the same plant. Breeding in and in can by absolute experiment, be proven to produce a degenerate offspring in the vegetable kingdom no less than in the human race. Now the marriage priests who officiate are insects in search of honey, the winds, or anything which by accident or design may carry the pollen from one flower to another.—*J. F. Rothbeck, American Naturalist, 1868.*

"Mr. Charles Darwin and other botanists have proved beyond a doubt that some flowers, in which the pollen may easily gain access to the stigma of the same flower, are sterile unless fertilized by pollen borne from other flowers, while many are much more productive by a cross fertilization.

"Bees are willing agents here, as in other instances, alighting first on the stigma of the oldest flowers, which are farthest down the stem, and then passing up to others which are younger. Besides collecting nectar at the bottom of the flower, they collect the pollen by scraping the style upon each side with their legs, and when calling at the next flower, first strike the exposed stigma, leaving a few little morsels as tribute for the bountiful supply."—*W. J. Beal, on "Agency of Insects in Fertilizing Plants," American Naturalist, 1868.*

"THE GREAT IMPROVEMENT OF THE STRAWBERRY

has been brought about by cross fertilization and selection of the best of each kind. Nature apparently is not willing to develop a luscious receptacle or berry unless she in turn can use it as a resting place for seeds."—*Minnesota Experiment Station Bulletin.*

"Orchards in which bee hives are placed bear heavier crops than those not thus favored. Bees are in Europe profitably introduced into peach houses in order to effect the polination of the flowers." —*Packard's Entomology for Beginners.*

At one time, we are informed, a person living in Pawtucket

attempted to grow strawberries under glass. He raised plenty of vines and blossoms but they produced no fruit. Some one who knew told him why, and when bees were procured the blossoms matured and produced fruit.

It is said that if strawberry blossoms are covered by fine muslin they drop off instead of maturing, but if fertilized artificially by hand they mature. Some of the best bearing varieties of strawberries only produce female blossoms or pistils, the Crescent Seedling being an example, therefore growers of this fruit have one row in every seven of a kind having an abundance of pollen, and that blossoms at the same time.

WHEN RED CLOVER WAS FIRST BROUGHT INTO AUSTRALIA,

although fine crops were raised, with plenty of blossoms, no seed could be secured. At last some one sent to England for "bumble" bees.

They were procured in winter, while dormant, by Mr. Abbott, a prominent English bee-keeper; were sent in that condition and successfully introduced. As soon as they became plenty there was no further trouble in securing a full crop of seed.

Honey bees work on second crop in this country at times.

Prof. Lucas, a celebrated pomologist in Germany, says: "A careful and observant bee-keeper at Potsdam writes to me that *his trees yield decidedly larger crops since he has established an apiary in his orchard, and the annual product is now more certain and regular than before*, though his trees had always received due attention."—*American Bee Journal.*

Frank Cheshire says that in each apple matured five fertilizations have been necessary. If none are effected, the calyx which forms the flesh of the fruit, instead of swelling, dies and soon drops. If some parts are fertilized those parts only develop, making a deformed fruit, and it rarely hangs long enough to ripen, becomes a windfall; also that gooseberries are absolutely dependent upon insects for fertilization, and the failure of this crop is not so uniformly the result of frost as some suppose, but from cold weather at the critical time, preventing the visits of bees. He believes the present development of the perfume, nectar secretion,

size, and beanty of flowers are the results of repeated insect selection.

IMMEDIATE EFFECTS OF CROSS FERTILIZATION ON THE FRUIT.

Not only do the highest authorities claim that insects are of the utmost importance for the fertilization of many fruits, seeds and vegetables, but that the fruit is in many cases immediately affected favorably or unfavorably according to the source of the pollen, thus guiding whatever feeds upon the fruit to select that having the seed best fitted for propagation.

"Among strawberry growers it is widely believed that the berries of pistillate varieties will vary in character according to the staminate variety which furnishes the pollen. As many of the best varieties of strawberries are pistillate and require to be fertilized by some perfect flowered variety, it becomes important to know with certainty whether such an influence exists or not."—*A. A. Crague, U. S. Agricultural Report.*

Charles Darwin, Dr. Gray, D. M. Ferry and others admit the possibility of this. Others believe that the more plenty the pollen the greater this influence.

"I have always thought that the more abundant the pollen and consequently more perfect pollinization afforded by some varieties, had as much to do with the result as any true effect of the cross fertilization.—*F. S. Earle, U. S. Agricultural Report.*

"We know it is claimed by some that peas and beans are self fertilized but we have learned that they are not always so, to our cost.

"A shower of rain washes away the pollen and our apple crop fails in consequence. The young fruit does not swell but shrinks and falls." . . . "It is believed that the pollen affects the tissues of the fruit itself." . . . "Where then shall we limit the action of the fertilizing element of the pollen? I am inclined to believe that it really has no limit, but that it is capable of extending through the whole plant.—*D. M. Ferry, Detroit, Mich., U. S. Agricultural Report.*

As Cheshire expresses it, bees are not only florists but fruit producers, and the nectar and pollen is simply the fee paid for the professional service of the little inoculator.

Bumble bees, wasps, butterflies and many other insects by day, as well as moths and the various insects of the night, do much of this work. They, however, must take their chances of surviving winter's cold or summer's wet, or drouth with its scarcity, and may be terribly thinned out in consequence.

Honey bees, which are doubly man's friend, may by him be fed and protected as well as bred in any quantity and taken wherever they may be needed.

They seem to be best suited to the flowers of our most important crops needing insect help.

"In Herman Müller's celebrated work (German) "The Fertilization of Flowers by Insects," there is a full description of 338 species of plants that are proved, by careful observation of many years, to be visited and fertilized by insects. This is about one-fifth of all the plants flowering in the open country in Germany. *The honey bee alone visits 194 species*, being half the number of plants examined."—*British Bee Journal.*

DO BEES INJURE FRUIT?

Prof. Riley, speaking of the many insects injurious to vegetation and the few that are beneficial, says, "The ability to distinguish between friend and foe is of the first importance in coping with the latter, for it is a notorious fact that the farmer often does more harm than good by destroying the former, in his blind efforts to save his crops."—"*General Truths in applied Entomology,*" *U. S. Agricultural Report, 1884.*

He says in a later Report, 1885, "Apiculture as an important branch of economic entomology, deserves attention, and there are some questions which this department can, perhaps, better consider than private individuals or associations. Mr. Nelson W. McLain was, therefore, appointed as special apicultural agent of the division," June 1st, 1885.

One of the various subjects given for investigation was, "To obtain incontestible results by intelligent experiment or scientific methods, as to the capacity of bees under exceptional circumstances to injure fruit, *i. e.* to set at rest the ever discussed question of bees vs. fruit." As to results of these investigations he says, "The experiments show conclusively that bees do not injure

fruit at first hand, and this fact is in keeping with the structure of the mandibles as compared with those of wasps which are generally charged with the real injury."—*C. N. Riley in Report of the Entomologist, U. S. Agricultural Report, 1886, page 211, 212.*

Hives of bees were confined to a bee proof building, made so by enclosing its open sides with wire cloth. Plates of grapes, peaches, pears and plums, varying from green to dead ripe, were placed on shelves in this enclosure. The bees were then deprived of stores and left with the exposed fruit as their only relief from hunger, thirst and starvation. We extract the following from Prof. McLain's Report, 337, 1885.

"They daily visited the fruit in great numbers, and labored diligently to improve the only remaining source of subsistence. They inspected and took what advantage they could of every opening at the stem or crack in the epidermis or puncture made by insects which deposit their eggs in the skin of grapes. They regarded the epidermis of the peaches, pears, plums and other fruits having a thick covering simply as subjects for inquiry and investigation, and not objects for attack. If the skin be broken or removed, they will, in case of need, lap and suck the juices exposed. The same was also true of the grapes, if the skin was broken by violence or burst on account of the fruit becoming over-ripe; the bees lapped and sucked the juices from the exposed parts of grapes and stored it in cells for food. They made no attempt to grasp the cuticle of grapes with their mandibles or with their claws. If the grapes were cut open or burst from over-ripeness the bees would lap and suck the juices from the exposed segments of the grape until they came to the film separating the exposed and broken segments from the unbroken segments. Through and beyond the film separating the segments they appear to be unable to penetrate. I removed the outer skin from many grapes of different kinds taking care not to rupture the film surrounding the pulp. When these were exposed to the bees they continued to lap and suck the juices from the outer film until it was dry and smooth as was the film between broken and unbroken segments. They showed no disposition to use their jaws or claws, and the outer film as well as the film between broken segments remained whole until the pulp decayed and dried up."

"After continuing the test for thirty days we sent to Michigan for varieties not obtainable here," another colony of Italian bees were added to the rest and twenty varieties of grapes again exposed upon plates and suspended from the rafters. "The conditions naturally prevalent during a severe and protracted drought were again produced and the test again continued for twenty-five days." "The bees showed no more capacity or disposition to offer violence to one variety of grapes than another. No more attention was given the thin skinned varieties than the thick skinned. As long as the skin remained whole they did not harm the grapes. When the skins were broken by violence, such as by cutting or squeezing, the juices exposed were appropriated.

The extent of damage the bees could do to grapes burst from over-ripeness, depended on the extent of the rupture in the film surrounding the pulp. A wide rupture may be made in the epidermis, or it may be removed and if the film is unbroken the pulp remains whole. The film seldom bursts until the grape is about to decay, or has begun to decay and then the grape is of little value."

Page 338. "Many erroneously suppose that bees sting the grapes. Bees never sting except in self-defence or in defence of their homes from real or imaginary danger."

"The evidence then shows that bees do not injure perfect fruit. We have observed that they give no attention to the puncture and blight caused by the ovipositing of other insects, until after the larva is hatched and decay has set in, and then only in cases of extremity.

The circumstances under which bees appear to be able to injure grapes are very exceptional. That they will not molest or even visit grapes when it is possible to secure forage elsewhere is certain. It also appears certain that they never attempt violence to the skin of grapes. The capacity of bees to injure over ripe grapes is limited by the extent to which the juice and pulp are exposed by the bursting of the film. If the film is only slightly burst the bees can do but little injury. If the progress of decay has caused a wide rupture in the film the bees more readily appropriate the juice."

"Mr. Richard Rees, a florist and horticulturist of many years

experience in the eastern and western States, informs me that he has very carefully observed the effect of bees upon flowers and fruits in the orchard, garden and greenhouse. He regards their presence as wholly desirable and altogether beneficial. During a term of four years he had charge of a large conservatory and garden in this city. At times he had as many as fourteen different varieties of exotic grapes in bearing in the conservatory, and from two to three tons of ripe grapes hanging on the vines at once. A large apiary was located near by, and late in the fall and early in the spring the flowers and fruits in the conservatory were visited by the bees in great numbers. The grapes were unmolested and the bees aided in fertilizing the flowers.

He says that he has had large experience in grape growing in vineyards and that he has never known any damage or loss from bees, and that when grapes are burst from over-ripeness, or decayed and blighted by the hatching of insect larvæ, to such an extent that bees can appropriate their juices, they are of little, if any value. He has never kept any bees, but he regards them as being of great service to floriculturists and horticulturists on account of the service rendered in fertilizing blossoms.—*Prof. McLain's Report, page 339.*

To the foregoing from the U. S. Agricultural Reports we add the following from eminent authorities:

"Apiphobia.—The people of Wenham have voted, that no bees shall be kept in town———the vote being directed against an extensive bee keeper whose stock has been troublesome. Some say the action of the town is of doubtful constitutionality."*—*Boston Journal, 1868.*

"The good people of Wenham have judged that bee keeping and fruit raising are incompatible, and that bees are a nuisance!! We also notice that the bee keeper 'whose stock has been troublesome,' advertises in the Salem *Gazette*, 'his farm for sale, consisting of three-quarters of an acre of tillage land containing from seventy-five to one hundred pear trees, beside apple trees. The pear trees, 1867, bore thirty bushels of choice standard fruit.'"

* Bees are now quite extensively kept in Wenham.

"Have we gone back to the days of belief in witches and witchcraft?"

"This disease, apiphobia as many call it, has affected mankind before. Among some of its attending symptoms are intense bigotry, (sometimes leading to much persecution) and an unreasoning credulity so that all sorts of horrible stories regarding these entomological monsters are eagerly believed. A little knowledge of Natural History is really the only antidote yet discovered against this fell disease."—*Prof. A. S. Packard, Entomologist (now of Brown University) in American Naturalist, 1869.*

"ARE BEES INJURIOUS TO FRUIT?"

"All the evidence given by botanists and zöologists who have specially studied the subject shows that bees improve the quality and tend to increase the quantity of fruit. They aid the fertilization of flowers and thus render the production of sound and well developed fruit more sure. Many botanists think if it were not for bees and other insects, many plants would not fruit at all. What is the use of honey? The best observers will tell you it is secreted by the plant for the very purpose of attracting bees to the flowers or fruit. If all the bees were to be destroyed, I for one, if a farmer, would prefer to go into some other business.

Farmers know too well the injury various insects do; it is more difficult to determine the good done by hosts of beneficial insects. I believe every intelligent bee keeper and naturalist will assent to the truth of the above remarks."—*Prof. Packard in "American Naturalist," 1869.*

BEES *vs.* FRUIT.—It is high time, we may add, that the Peabody Academy of Science were in full operation in Essex county when one of its towns vote to abate the nuisance of bees, on the ground that they are injurious to fruit."

"As to the nectar of the red clover being out of reach of the honey bee, it may be asked whether this be the case with the second crop, in which the flowers are generally rather smaller. The much better seed of the second crop is thought to be owing to the greater abundance of bumble bees in the latter part of summer." —*Prof. Gray, in "American Naturalist," 1869, page 160.*

The Professor of Botany, Brown University, W. W. Bailey, says

he "has no doubt of the great value of bees in the fertilization of fruit and other crops."

That bees work on over-ripe or bruised peaches, pears, raspberries and grapes when no honey can be found is admitted. Where such fruit is of value, can be saved and dried or canned, there might be some loss if left exposed where there are large numbers of both wasps and bees near. The housewife saves apples from further decay for a time, by cutting out the soft spots; may not bees do the same in some cases by removing the free juice from the soft and bruised parts of the fruit?

It is noticeable that peaches and other fruits decay most in wet seasons and these seasons are usually the ones when most complaints are made against bees. Prof. McLain found that grapes hung in a hive of starving bees kept longer than those left on the vines.—*Page 338, Agricultural Report, 1885.*

Fruit juice is a source of disease to bees and if secured in any quantity is liable to cause the loss of the colony in winter. It is for the interest of all bee keepers to exclude such stores from the hives.

THE TESTIMONIES OF A FEW PRACTICAL GROWERS IN OUR STATE

might be of use here.

Mr. James A. Budlong, of Cranston, has grown cucumbers as a specialty for 40 years, and is of the firm of James A. Budlong & Son, the largest market gardeners in the State, if not in New England, especially as growers of cucumbers and pickle stock. He says, *he would as soon try to raise a crop of cucumbers without water and manure, as without bees, in a closed greenhouse.* Without them there would be no crop, they all run to vines and the blossoms and small cucumbers drop off. With open windows he would expect part of a crop. He always places hives of bees in the greenhouses when the vines blossom. Furthermore he says, for out door crops, such as cucumbers, squashes, pumpkins, &c., he considers bees necessary though the wind does some of the work. A large apiary near by would not be unwelcome.

The greenhouse and garden products of Dexter Asylum, Providence, are probably next in extent to that of the Budlong Farm. Mr. F. B. Emmons, the one in charge of this work, says he would

get no cucumbers in greenhouses without bees. He thinks they are also of use in raising early melons. He has noticed that melons under hotbeds drop off until glass is removed or raised, alse that squashes yield better since bees have been plenty about there. In his opinion they do not hurt fruit that is good for anything, though at times they work on pears, peaches, &c., that are soft. He believes wasps cut the fruit. He has noticed after very hard winters that there is hardly a bumble bee to be seen though several years later they will be plenty. Thinks if bees were more plenty through the State the farmers would be gainers. On a stand built in a small walled in garden patch were several hives of bees that had been of service in the greenhouses early in the spring.

Isaac Hazard & Son, South St., Providence, raise cucumbers under glass to quite an extent, and inform us that they find it necessary to have a hive of bees where they can visit blossoms in order to get a paying crop.

Mr. N. D. Pearce, of Norwood, is probably the largest grower of peaches in the State. He marketed 500 baskets of peaches the past season and would have sold 2,000 if the wet season had not spoiled most of the crop. He does not consider bees his enemies though they often work on peaches unfit for market. As to their importance in fertilizing the peach bloom or insuring a crop he could not give any decided opinion from observation.

Mr. F. H. Perry, the Providence preserver of fruits in glass, and who also grows and exhibits grapes, said his grapes at one time were cracked and covered with bees who were sucking the juice and he gave them the blame, but having seen it in print that honey bees do not cut or injure sound fruit, he noticed more particularly and found a yellow striped insect, two-thirds the size of the honey bee, who might be the party doing the work though bees were most plenty. Something punctured the grapes.

Robert Cushman, of Pawtucket, a prominent grower and exhibitor of different varieties of fruit, and especially grapes and pears, says he knows honey bees work on cracked grapes and over-ripe peaches and pears but "whether they ever break the sound skin of pears, peaches or grapes, I have no knowledge."

The Lewis Dexter Farm, near Lime Rock, has produced for many years if it does not now produce, the greatest quantity and

variety of pears for market, of any farm in the State and it is a significant fact that in Mr. Dexter's day, and also while Mr. Plew, (formerly Mr. Dexter's gardener), owned it, a half dozen or more hives of bees were a part of the live stock of the place.

The decision of the Supreme Court of Arkansas is that bee keeping is a legitimate business and is not a nuisance, and that the city ordinance against bee keeping in Arkadelphia is illegal and void. (June, 1889.) Some of the points in the defense of Judge Williams, who won the case before the court, may be summed up as follows:

Because people are afraid of bees they are not a nuisance. They are no more liable to sting people than horses are to kick, or an ox to gore them, and no more of a nuisance than cows, horses, dogs and cats, and should have equal rights with them.

If because bees may sting they may be prohibited, then because cows may gore, dogs annoy the sensitive, by barking or biting, or running mad we will also prohibit them.

Because vehicles may annoy by raising dust, or making a noise, or animals may run away in harness, we prohibit them. No such power is necessary or given to Legislators or municipal bodies. Bees are property and entitled to protection.

BEE LAWS IN GERMANY.

A bill of 16 paragraphs designed to promote bee keeping entitled the "Bee Protection Act," has lately passed both houses of the German Parliament and took effect Oct. 1, 1889. We give a few articles of the decree from the *American Bee Journal.*

"1. The privilege of bee keeping to all inhabitants on their own property."

"2. The same right to all renters or lease holders, by permission of the owner of the property."

"3. Apiaries may be established any where, against objections of neighbors, by enclosure of at least 2½ metres high; from April 1st to October 1, 10 metres high, (this in case of neighbors objecting.")

"6. Apiaries will be protected by civil right and law."

"13. Any one who wilfully or maliciously in any way destroys (so-called robber bees) by water, fire, steam or poison, or trap,

shall be fined 600 marks, (about $150.00), or an imprisonment for one year."

The fact that such a law has been passed in Germany, by a Parliament representing over sixty millions of people, and by a Government which has done more than any other to encourage advanced farming and spread scientific knowledge relating to the same, is worthy of consideration in connection with the views brought forward in these pages.

CONCLUSION.

We believe and have endeavored to show that bee keeping is of sufficient importance to deserve the encouragement and protection of the State.

That bees are of great service to growers of various crops, as well as profitable to their keepers for their honey and wax.

That honey bees do not injure sound fruit, and that the damage done to unsound fruit must be comparatively light.

That to prohibit bee keeping is unconstitutional, and that no one need refrain from keeping them on account of their neighbors (though all reasonable precaution should be taken to prevent annoyance or accident).

That this prejudice against bees is sure to give way to public opinion in their favor.

That a widespread knowledge of bee keeping would increase the products of the State.

REPORT OF THE APIARIST.

Though appointed Apiarist March 11th, little could be done until May, except to engage by correspondence bees, queens, hives, and supplies. The farm was visited and a place selected for the apiary. Though a south-eastern slope and exposure was preferred, the spot chosen as most favorable, slopes to the south and west, is protected on the north and east by the hill, and on the south by adjacent groves of trees. On the west, where there was no protection from the winds that sweep the valley, it was planned to build a high board fence for a wind break.

May 1st, ten colonies of hybrids, bought at a reasonable price in another part of the State, were prepared for shipping (frames were immovably fixed, wire cloth was tacked on in place of cover, and entrances closed) and sent by freight.

The apiarist, bees and supplies were on the ground May 2nd. The new hives were put together and painted, the bees and combs transferred to them and the colonies located in position.

The work since, which has been done during periodical visits of a few days each week, fortnight, or month, as the bees required attention, has been to make, as near as possible, a model working apiary with everything in the best condition.

Drone and inferior worker combs have been replaced by those of all worker cells built on foundation. Worker combs that were crooked or built across the frames have been straightened or fitted in the frames. Failing queens, or those whose workers were vicious, have been removed and replaced by young ones from the best representative stock of the country, or by choice ones reared in the apiary. Two Carniolan queens were also procured, one imported from Germany the other bought of an American importer.

A new building put up for the temporary use of this department, and intended for a poultry house in the future, was fitted with convenient benches, provided with screens on windows and door, and has served its purpose nicely.

A few hives were run exclusively for comb honey, others for extracted honey, but the wet season defeated our purpose.

Most of the honey gathered was used up by increase and queen rearing, and the tests as to the relative value of natural base and flat bottom foundation in both brood and surplus boxes had to be postponed until another year.

A single comb glass hive of Italian bees, with surplus case above, was set up in the workshop and bees allowed to fly in and out through a hole in the side of the building. By removing the outer panels of wood the bees could be seen at work, the queen found, and many of their most interesting habits studied. This was a source of much satisfaction to visitors.

One hive of fair strength was placed on scales and daily weighed. This was done each morning, between four and five o'clock, by a careful man, before the bees had left the hive. The gain or loss was recorded each day and the hive left balanced. This plan is followed in many large apiaries and gives the apiarist valuable information. We give the record from June 11th to July 24th.

RECORD OF HIVE ON SCALES.

JUNE.		JULY.	
11	Gain ... 0 Lbs.	1	Gain ... ¼ Lbs.
12	" ... 1½ "	2	" ... 0 "
13	Loss ... 1¼ "	3	Loss ... ¾ "
14	Gain ... 1 "	4	" ... ¾ "
15	" ... 1 "	5	" ... ¾ "
16	" ... ½ "	6	" ... 1½ "
17	" ... ½ "	7	" ... 1½ "
18	" ... 0 "	8	Gain ... ¾ "
19	Loss ... ½ "	9	" ... 1½ "
20	" ... ¼ "	10	Loss ... 1 "
21	Gain ... 2 "	11	" ... 1 "
22	" ... ¾ "	12	" ... ½ "
23	Loss ... ¼ "	13	Gain ... 2 "
24	" ... 0 "	14	Loss ... ½ "
25	" ... 1 "	15	Gain ... 2¾ "
26	" ... 0 "	16*	Loss ... ½ "
27	Gain ... 1 "	17	Gain ... 1 "
28	" ... ¼ "	18	" ... 2 "
29	" ... 2¼ "	19	Loss ... ½ "
30	" ... ½ "	20	Gain ... ½ "
		21	Loss ... 1 "
		22	Gain ... ½ "
		23	Loss ... 1½ "
		24	" ... 0 "

*16.—9 o'clock, 1 lb. less than 4.30; 2 o'clock, 3 lbs. less; 8 o'clock, 1¼ lbs. more.

The date is of the morning weighing, and the amount given shows the gain or loss during the previous day. Days on which there was a gain were followed by many that were wet and stormy upon which the stores were drawn upon for brood rearing.

Some of the loss in weight was due to the evaporation of water from the thin nectar.

On July 16th the hive was weighed at 4.30 as usual and again at 9 o'clock A. M., and 2 and 8 o'clock P. M. The first weighing showed that during the previous 24 hours there had been a loss of ½ lb. The scales were then balanced. At 9 o'clock the weight was 1 lb. less than at 4.30; at 2 o'clock 3 lbs. less, and at 8 o'clock 1¾ lbs. more.

At 9 o'clock enough bees had gone to the fields to lessen the weight 1 lb. (We do not here take into account the small amount of honey or nectar brought in, or on the other hand the evaporation of water during this time.) At 2 o'clock 3 lbs. of bees were out, consisting of field bees and young bees just out for a fly. Yes, more than 3 lbs. if we make any account of the honey which must have been brought in by this time.

At 8 o'clock the bees were all in for the night (bees are often chilled or belated in the fields and do not return until the sun has warmed them the next day) and the hive weighed 1¾ lbs. more than in the morning. But this gain is thin nectar; let us see how much is lost during the night by evaporation as well as by the honey eaten; given off as vapor by the breath of the bees.

The next morning the 17th, the gain in 24 hours had been 1 lb., therefore there was a shrinkage of ¾ lb. during the night.

During this period, 44 days, the greatest loss in 24 hours was 1½ lbs., the greatest gain in 24 hours, 2¾ lbs. There were 20 days on which there was a decided gain, 6 on which there was neither loss or gain, and 18 days on which there was a loss. The sum of the gain is 22½ lbs., the sum of the loss is 15 lbs., leaving a balance of 7½ lbs.

The surplus of the year is usually gathered in a short time, often inside of 12 days, and a long continued rain at this time is a serious matter to the bee keeper.

Though this record for the past season makes such a poor showing in the amount of honey, much may be learned from it and its

great value to the bee keeper at the time of a sudden and heavy flow of nectar may be seen. The general condition of the apiary may be known each day; whether or not immediate attention, and more or less room must be given, and this without opening a hive.

Bees in the northern part of the State did much better than those about Kingston this season.* In a very dry summer we should expect the reverse of this.

As the Fair of the Washington County Agricultural Society, held at Kingston early in September, afforded a favorable opportunity, the management decided to make an exhibit of bees, queens and hives, therefore we prepared and exhibited 5 single comb glass hives, plainly showing Black, Italian, Cyprian and Carniolan bees and queens, and Syrian bees with queen cells; a full colony of Italian bees in glass hives as worked for comb honey (these were allowed to fly out-doors through a wire-covered passage, and as they went and came attracted much attention), also a swarm of bees clustered on a branch as in natural swarming, and a collection of hives and fixtures, consisting of comb honey hive, outer case or winter hive, comb foundation, honey extractor, honey knives, smokers, shipping cases, queen cages, &c.

The whole gave a good idea of the stock, hives and fixtures used in bee keeping, and much interest was manifested in it.

The bees were returned to their hives in the apiary without accident and with comparatively small loss, though such exhibits always use up more or less bees. The small hives of bees in the apiary used as temporary quarters for queens were immediately doubled up or given to any that might need more bees, and as nearly as possible all left with sufficient numbers for winter.

Feeding was then commenced and finished as quickly as possible. The feed used for the winter stores was made of best granulated sugar dissolved in boiling water to which was added one-fifth good thick honey.

After the removal of the feeders the frames were covered with muslin ready to receive the packing which was not given until early in November.

Sixteen colonies were prepared for winter. Three were put in the farm house cellar and thirteen left on their summer stands surrounded by a water tight outer case in which there is room for

several inches of packing on all sides as well as above. Cork sawdust was used for packing and a large sack filled with it was also placed above the frames of each hive.

To prevent the hives being overturned by winds, a cord was thrown over each and fastened to stakes driven into the ground on each side.

Instead of making comparative tests of the various methods of preparation for winter, we have arranged them according to the most approved plans, that there may be as little loss as possible this season. The hives will be left until the middle of April without disturbance except to see that entrances do not get clogged.

The best methods of preparing syrup for winter stores, a list of and description of the various varieties of bees in the apiary, as well as other questions suggested in these pages, may be considered in a future BULLETIN.

AMERICAN HIVES.

American hives without doubt excel all others for practical work, but there is a great variety of kinds. Men equally successful use entirely different fixtures. Most hives have excellent features but some have more than others, and to get the most of them in one hive is the object of all. Hives are often ordered only to find them worthless or different from what was wanted. Many beginners go through this; they have no idea of what they want; as one is discarded another is tried; they are continually trying hives, until no two in the yard are alike; and the principal advantage of a frame hive is lost. That is, the adaptability of every part of each hive to any other hive, thus making possible doubling, dividing, changing combs of brood or honey, tiering up, &c.

Those who commence with a good hive and stick to it are fortunate. Except in the matter of first expense, those who order each kind, study them all, decide on one and sell or throw away the rest are more fortunate. This plan, next to that of making a tour of all the different large apiaries in the country, is probably the best, though the money required for samples and the freight or express on them would start quite an apiary.

That this expense may be saved each individual and that by visiting the Experiment Station all may have the advantages of study-

ing these different hives, a collection of the various patterns used by honey producers as well as those advertised by manufacturers, has been commenced, and is designed for a permanent exhibit.

The following is a list of those thus far procured.

Cary's Chaff Hive; removable outer case; comb honey supers.

Manum's Bristol Chaff Hive; removable outer case; comb honey supers.

Smith's Chaff Hive; removable outer case; comb honey supers.

Hilton's Chaff Hive; permanent outer case; comb honey supers.

Root's Chaff Hive; permanent outer case; comb honey supers.

Falconer's Chautauqua Hive; dead air space; permanent outer case; comb honey supers.

Quinby Frame Langstroth Hive; double wall; super for extracted honey.

Cary's Langstroth Hive; comb honey supers.

Cary's Simplicity Hive; single wall; comb honey supers.

Root's Simplicity Hive; single wall; comb honey supers.

Root's Dovetailed Hive; single wall; comb honey supers.

The Bingham Hive; single wall; shallow frame.

Heddon's New Hive; single wall; shallow frame; comb honey supers.

Crane's surplus case for comb honey.

Manum's Lightning Gluer for sections.

Manum's Smoker.

Bingham's Smoker.

Clark's Smoker.

Bingham's Honey Knife.

Root's Honey Knife.

Root's Comb Bucket.

Root's Honey Extractor.

Root's Sun Wax Extractor.

Miller's New Foundation Fastener.

Mr. Manum is the most extensive producer of comb honey in New England.

Charles Dadant & Son, of whom the large Quinby Hive was procured, are among the most extensive producers of extracted honey in the West.

Donations of hives, fixtures, or anything of sufficient interest to be preserved with this collection will be received and acknowledged in the BULLETIN.

Samples of various kinds of honey from all parts of the country are solicited.

DONATIONS ACKNOWLEDGED.

The following hive manufacturers have donated hives as follows:

W. W. Cary, Coleraine, Mass.,—Cary Langstroth Hive; Cary Simplicity Hive; Cary Chaff Hive.

W. T. Falconer, Jamestown, N. Y.,—Chautauqua Hive.

James Heddon, Dowagiac, Mich.,—New Heddon Hive.

George Hilton, Fremont, Mich.,—Hilton Chaff Hive.

Charles H. Smith, Pittsfield, Mass.,—Chaff Hive.

A. E. Manum, Bristol, Vermont, has presented one of his best Italian Queens, A. C. Miller, of Providence, his new machine for fastening foundation in sections. A bottle of extracted honey from the palmetto palm, and produced by S. C. Corwin, Sara Sota, Florida, has been received from Mrs. J. N. West, of Providence.

This department has also received liberal discounts on goods bought of A. I. Root, Medina, Ohio, Hive Manufacturers and Supply Dealers; Chas. Dadant & Son, Hamilton, Ill., Manufacturers of Natural Base Comb Foundation, and from J. Van Deusen & Sons, Sprout Brook, N. Y., Manufacturers of Patent Flat Bottom Comb Foundation.

All bee keepers in the State are respectfully urged to send their address to the Bee Department, Experiment Station, Kingston, R. I.

We wish to acknowledge our obligations to Prof. Packard, of Brown University, for valuable aid rendered in our quest for authorities on questions considered in the pages preceding this report.

SAMUEL CUSHMAN, *Apiarist.*

POTATOES.

L. F. KINNEY.

BULLETIN No. 5.

METHODS OF PLANTING AND TEST OF VARIETIES.

Much difference of opinion exists among potato growers concerning the merits of the various methods of planting now practised, and the comparative value for production for market and for home consumption, of the many varieties of potatoes that are each season offered for sale for seed purposes. In consideration of these facts, together with a knowledge of the importance of the potato crop as a source of one of our staple articles of food, a series of experiments was begun during the past summer at the Experiment Station, with the object of solving so far as possible the following questions, viz.:

1. Is the yield of a hill of potatoes mainly determined by the space allotted to it in the row and the condition of the soil; or is it materially influenced by the amount of seed potato planted?
2. Is the size of potatoes influenced by the quantity of seed planted?
3. What varieties are best adapted to our soil and climate?
4. Are northern grown potatoes better for seed than home grown?
5. What varieties are least subject to the potato rot?

The field used for the experiment was new land, the soil loam, with a yellow loam subsoil, and the natural drainage good. About six cords of stable manure to the acre were spread broadcast and turned under with the sod.

After being thoroughly harrowed, the field was furrowed out, May 9th, into rows 104 ft. long and 3 ft. apart, each row being divided into three sections 33⅓ ft. long, having two open spaces of 2 ft. each between the sections.

Before the potatoes were planted, a fertilizer composed of 2-7 parts of muriate of potash, 2-7 parts of tankage and 3-7 parts, by weight of ground bone, was scattered as evenly as possible in the furrows at the rate of 1,000 lbs. per acre. This was mixed with the soil by running an Ajax cultivator, shut up closely, through the rows, which also left the soil in a smooth and mellow condition to receive the seed. On the two following days, May 10th and 11th, the potatoes were planted, one hundred and fourteen rows in all, including eight rows of duplicate varieties, that the products from seed grown in this latitude might be compared with the yield from seed of the same kind grown farther north.

Three pounds of seed potatoes were planted in each row, being divided equally in three sections, thus allowing one pound to each 33⅓ ft. of section of a row.

In the first section the pound of seed was cut into single eye pieces and planted in 44 hills each 9 inches apart.

In the second section the pound of seed was cut into two eye pieces and planted in 22 hills, each 18 inches apart.

In the third section the potatoes were planted whole in eleven hills, or only cut sufficiently to fill out the section with the hills 36 inches apart.

The weather being favorable, all of the varieties came up evenly. The field was cultivated four times during the summer with a Planet, Jr., cultivator, and in addition the soil was drawn towards the vines twice by hand.

The Potato Beetles were easily kept in check by the use of London Purple, which was thoroughly mixed with land plaster and applied with a "Farmer's Favorite Potato Bug Exterminator." The proportions used were ½ lb. of London Purple to 75 lbs. of plaster.

About July 20th, during the hot wet weather that prevailed after the excessive rainfall of the month, potato vines blasted very generally throughout the State, and although many of the varieties in the experimental field were at that time in full blossom, they all succumbed to a common fate, the vines dying and all growth ceasing before August 1st.

Had the growth been permitted to mature, the results recorded in the following table would undoubtedly have been somewhat modified, yet a careful inspection of the same will not, we trust, prove wholly without profit to those who will follow the series of experiments from season to season until satisfactory conclusions can be obtained.

The figures in the first six columns show the yield of both the merchantable and small potatoes of each variety as grown by each of the three systems of planting, calculated to bushels and hundredths of bushels per acre. Potatoes weighing two ounces or over being classed as merchantable.

The seventh column shows the average total yield of each variety as grown by the three systems.

The eighth column shows the per cent. of the total number (both merchantable and small) affected by the potato rot.

The seed of the first one hundred varieties was grown at Newtown, Conn., latitude 41° 25' n., with the exception of the Louisa, which was grown at Rittman, Ohio.

The seed of the remaining fourteen varieties was grown at Oshkosh, Wis., lat. 44° n.

Duplicate varieties are marked with a (*).

Yield Calculated to Bushels and Hundredths of Bushels per Acre.

Variety of Potato Seed Grown at Newtown, Conn., Lat. 41° 25′ N.	Section 1.		Section 2.		Section 3.		Average total yield.	Per cent. of total number affected by rot.
	Merchantable.	Small.	Merchantable.	Small.	Merchantable.	Small.		
American Giant	43.56	23.58	51.89	20.52	30.40	11.34	60.43	8 per ct.
Andrew's White Rose	21.78	51.72	15.30	48.13	10.23	26.28	57.82	4 "
American Magnum-bonum	28.34	12.76	40.74	9.98	19.61	10.43	40.62	5 "
Alexander's Prolific	20.87	34.18	41.39	23.14	37.20	18.50	58.41	3 "
Bliss' Triumph	44.01	56.98	58.98	50.82	54.83	41.74	103.12	3 "
Buffalo Beauty	26.31	40.83	22.68	40.83	19.61	19.89	56.71	2 "
Bonanza	31.33	13.52	31.57	16.33	20.12	18.58	43.82	1 "
Brook's Seedling	40.98	38.70	40.36	39.93	21.78	18.60	66.12	1 "
Belle	55.90	14.97	56.30	16.58	29.94	16.11	63.26	5 "
Burpee's Superior	36.75	20.15	37.20	19.96	29.04	18.15	53.75	3 "
Brownell's No. 31	18.75	48.24	32.67	52.28	15.42	36.75	68.04	6 "
Banana	25.55	24.19	19.05	50.67	13.15	29.04	53.88	6 "
Brownell's Success	27.00	43.10	15.02	38.21	11.79	21.67	54.26	4 "
Brownell's No. 55	14.20	32.21	12.37	39.52	8.33	44.46	50.36	2 "
Baker's Imperial	15.42	52.63	33.12	44.46	8.73	30.51	61.62	7 "
Borough's Garfield	10.88	47.18	32.66	48.55	25.10	38.11	67.49	4 "
Crandall's Beauty	29.32	25.10	33.25	29.36	25.22	23.92	55.39	6 "
Champlin	30.90	43.10	33.91	33.67	28.12	30.15	66.62	8 "
Collum's Superb	14.52	45.37	15.63	46.82	40.20	14.35	58.96	4 "
Clark's No. 1	23.32	26.91	24.64	46.28	30 65	18.60	50.13	5 "
Climax	14.06	49.00	21.32	45.83	26.30	31.72	62.74	7 "
*Crown Jewel	15.42	37.20	32.67	51.27	40.38	26.46	67.80	10 "
*Crane's June Eating	15.42	42.19	34.03	22.83	19.51	19.75	51.24	8 "
Connecticut	9.10	13.97	15.41	34.13	14.79	19.33	35.58	1 "
Churchill's Seedling	41.29	24.59	43.13	25.40	39.74	15.65	63.27	3 "
Cayuga	55.89	22.83	58.54	34.48	64.88	13.61	83.41	8 "
Cherry Blow	41.29	24.59	47.02	24.69	59.11	26.96	74.55	5 "
Chessman's Seedling	22.83	40.10	43.38	35.83	37.28	31.30	70.24	3 "
Chicago Market	31.30	48.09	31.76	60.80	33.57	25.55	77.02	8 "
*Chas. Downing	26.46	59.55	30.51	58.98	48.33	41.74	88.52	2 "
Cambridge Prolific	29.94	20.41	49.00	41.29	34.13	18:14	64.30	2 "
Centennial	22.38	46.28	36.75	37.77	32.66	30.02	68.62	4 "
Early Ohio	17.24	51.27	42.19	30.85	12.25	21.10	58.30	6 "
Early Gem	37.20	52.63	23.74	53.09	37.20	38.57	80.81	6 "
Early Waterford	19.05	38.11	22.09	36.75	20.87	33.12	56.66	14 "
Early Rose	36.85	18.27	22.83	40.94	35.84	36.85	63 86	8 "
Early Electric	19.92	46.38	10.69	40.54	21.59	23.46	54.19	5 "
Early Perfection	26.01	36.92	23.37	27.89	32.27	36.30	60.92	8 "
Eno's Seedling	19.55	29.96	22.11	29.40	32.27	18.35	50.55	13 "
Early Maine	15.92	29.98	21.59	44.30	25.10	28.27	55.05	5 "
Early Vermont	26.46	30.85	28.26	26.46	30.15	12.21	51.46	6 "
*Early Sunrise	15.26	18.07	28.25	42.19	32.08	20.14	51.99	10 "
Early King	34.03	32.25	33.11	30.18	21.32	32.25	61.04	7 "
*Early Beauty of Hebron	25.49	26.80	24.16	30.60	53.09	26.80	62.31	3 "
Eureka	9.98	28.56	18.00	35.15	36.30	15.18	47.72	11 "
Gen. Logan	38.11	36.75	48.09	49.80	33.57	19.51	75.27	3 "
Granger	15.87	32.90	34.55	32.17	8.75	32.68	52.31	8 "
Gold Band	29.87	46.28	38.55	51.27	36.17	35.07	79.07	3 "
*Green Mountain	36 19	30.05	40.41	32.17	35.18	28.33	67.44	4 "
Home Comfort	31.85	20.74	40.15	26.30	38.17	20.16	59.12	2 "
Hampden Beauty	33.57	49.91	32.65	53.09	37.77	34.07	80.32	5 "
Improved English Variety	19.34	25.10	24.85	33 50	24.75	19.07	48.87	3 "
Jones's Prize Taker	54.17	33.58	58.10	36.80	38.48	14.23	78.45	6 "
Late Rose	46.35	48.14	63.23	25.87	35.46	19.73	79.59	4 "
Late Snow Flake	25.14	34.57	38.40	17.83	30.17	15.65	53.92	5 "
Lee's Favorite	44.13	35.86	50.80	37.12	36.15	29.81	77.96	5 "
Late Beauty of Hebron	38.27	30.50	43.85	27.30	28.64	23.14	63.92	13 "
Morning Star	48 14	12.25	49.73	24.60	31.54	26.45	64.24	8 "
Moore's Seedling	29.37	30.45	38.60	26.14	26.01	19.45	56.67	7 "
Mammoth Pearl	19.91	32.21	43.03	25.14	33.64	20.60	58.18	11 "
Mitchell's Seedling	23.42	22.21	33.76	32.90	26.01	10.83	49.71	9 "
Idaho	14.12	38.43	43.36	30.90	29.04	24.46	60.10	2 "
Newton's Seedling	36.19	35.40	38.73	40.15	27.54	20.18	66.60	2 "

Yield Calculated to Bushels and Hundredths of Bushels per Acre.

Variety of Potato Seed Grown at Newtown, Conn., Lat. 41° 25′ N.	Section 1. Merchantable.	Section 1. Small.	Section 2. Merchantable.	Section 2. Small.	Section 3. Merchantable.	Section 3. Small.	Average total yield.	Per cent. of total number affected by rot.
Nott's Victor	41.40	32.21	39.36	43.74	28.54	21.35	68.86	6 per ct.
New Champion	27.36	18.11	44.01	20.98	33.74	15 60	53.25	4 "
Orange Co. White	51.78	20.09	47.20	24.99	44.36	21.34	69.92	5 "
Princess	33.07	31.17	30.71	46.33	28.54	33.74	67.82	6 "
Pearl of Savoy	33.74	24.30	34 72	40.09	24.79	24.93	60.85	14 "
Pride of the West	31.76	24.07	15.14	15.28	32.21	17.10	45.18	8 "
Pride of Erin	13.10	60.35	17.68	52.14	14.20	30.54	62.67	3 "
Potentate	32.21	19.51	35.60	16.52	32.66	20.87	52.45	17 "
Pride of Palestine	30.51	44.46	32.66	38.15	28.13	31.31	68.40	3 "
Pride of America	23 25	46.09	25.20	30.51	28.13	33.57	62.25	2 "
Putnam's Seedling	19.05	28.13	23.59	36.75	29.40	19.05	51.99	10 "
Queen of Roses	9.98	12.70	38.11	17.69	41 29	24.50	48.09	8 "
Rocky Mt. Rose	34.93	29.95	41.74	30.85	41.74	32.66	70.62	7 "
Rosy Morn	41.29	39.93	39.47	33 57	34.03	30.85	73.04	7 "
Rose's Invincible	29.49	26.48	17 24	23.59	19.96	24.05	46.93	2 "
Rural Blush	31.60	27.22	56.26	41.29	34.48	42.19	77.68	4 "
No. 80. (Seedling)	25.86	27.22	14.06	32.66	21.78	28.13	49.90	0 "
Rose of Hebron	26.31	46.28	38.11	36.30	27.67	36.75	70.47	3 "
Silver Chill	32.21	32.66	35.40	27.22	37.20	26.75	63.81	2 "
Sunlit Star	50.82	39.02	55.35	31.33	47.19	28.13	83.94	2 "
Stanton's Seedling	36.30	35.39	29.04	30.85	45.37	27.22	68.05	6 "
Storr's Seedling	39.93	21.32	35.84	22.69	25.42	20.41	55.20	3 "
Summit	52.63	35.13	40.83	38.62	51.27	26.14	81.54	3 "
Tonhocks	46.73	53.09	31.30	41.74	29.49	43.56	81 97	3 "
*Thorburn	43.10	83.49	38.15	63.97	39.02	43.56	103.76	2 "
*Early Puritan	58.08	58.08	44.46	50.90	46 28	41.74	99.84	4 "
Vick's Extra Early	13.61	36.30	12.58	24.65	15.99	20.87	41.33	4 "
Vermont Champion	29.04	34.48	33.61	36.96	28.13	17.69	59.97	5 "
Vanguard	38.11	36.14	39.02	37.65	37.77	31.96	73.55	5 "
Winslow's Seedling	36.30	22.68	51.27	25.86	44.46	24.95	68.50	7 "
White Elephant	44.46	35.84	48.30	37.63	40 38	18.60	71.73	7 "
Webb's Early	42.65	39 47	47.02	35.66	63.07	24.06	83.97	5 "
Weld's No. 22	43.10	6.35	54.75	4.08	37 22	7.26	50.90	6 "
White Flower	33.12	45.37	46.28	32.66	42.19	29.04	76.22	½ "
Jordan Russet	48.55	22.23	35.39	24.50	29.94	16.78	59.13	8 "
Steuben's Chief	37.20	9.07	63.07	8.16	38.58	4.06	53.38	3 "
Louisa	28.54	31.42	33.46	27.33	24.16	20.09	55.00	4 "
Average	21.66	24.98	25.35	25.25	22.44	18 61	46.03	5⅓ "
	46.64		50.60		41.05			

Seed Grown in Oshkosh, Wis., Lat. 44° N.

Variety	Section 1. Merchantable.	Section 1. Small.	Section 2. Merchantable.	Section 2. Small.	Section 3. Merchantable.	Section 3. Small.	Average total yield.	Per cent. of total number affected by rot.
Angell's No. 27	58 98	31.76	50.15	26.05	17.69	15.42	66.68	3 per ct.
Badger State	34.08	24.50	39 93	16.33	36.30	17.24	56.11	5 "
Crown Jewel	48.56	41.29	58.53	24 50	49.91	31.31	83.03	5 "
Chas. Downing	33.12	45.83	38.11	28.58	15.42	35.84	65.63	0 "
*Early Beauty of Hebron	21.32	19.96	53.09	46.73	15.99	25.40	60.83	4 "
Early Mayflower	14.97	17 24	55.81	17.24	33.57	15.42	51.42	4 "
*Early Puritan	38.11	32.66	24 95	30.51	25.40	25.86	59.16	6 "
Early Albino	40.83	23.59	21.78	23 25	40.83	28.13	59.47	6 "
*Green Mountain	29.04	16.79	35.86	21.78	26.77	19.05	49.76	7 "
*June Eating	25.86	32.21	53.54	28.58	22.23	20.87	61.09	6 "
Ohio Jr	26.31	25.86	39 93	31.76	43.56	15.99	61.14	3 "
Pride of Wisconsin	39.47	32 21	45.37	44.93	25.40	19.05	68.81	6 "
*Sunrise	25.40	24.05	46.03	34.48	56.71	21.78	69.15	2 "
*Thorburn	30.85	28.13	45.37	19.05	50.82	8.73	60.98	1 "
Average	32.92	28.30	43.34	28.13	32.90	21.43	62.34	4 per ct.
	61.22		71·47		54·33			

An examination of the preceding table shows that this season the method of planting practiced in Section II., viz., two eye pieces planted 18 inches apart, has given the best results; the average yield by this method being more than eleven per cent. greater than that of Section I., where single eye pieces were planted 9 inches apart, and nearly twenty-eight per cent. greater than in Section III., where whole potatoes were planted 36 inches apart. The average proportion of small potatoes was, however, this season, largest in Section II. and slightly less in Section I. than in Section III.

Potatoes weighing 6 oz. and over were classed as large (not shown in the table) and appeared about equally in Sections II. and III. but less frequently in Section I.

As a rule the heaviest potatoes grow in Section III., where whole potatoes were planted. An inspection of the last part of the table shows that the average yield of the entire list of the varieties obtained in the north-west was somewhat larger than a similar average of the yield of the preceding one hundred varieties; yet as a comparison of the yields of the eight similar varieties designated by a star (*) does not coincide with the above, but, on the contrary, shows that the largest yield was produced from seed grown in Connecticut, we are inclined to look for some cause other than the source of the seed for this variation of productiveness. At least no deductions of value can safely be made from this single trial.

It will be noticed on the table that the yield has varied considerably with different varieties. The comparative productiveness of each variety can, however, be easily determined by an examination of the figures in the seventh column. The average yield of the entire list being 54.19 bushels per acre. The five kinds giving the largest yield are in the order of their productiveness as follows:

Thorburn, ...	103.76	bushels per acre.
Bliss' Triumph, ...	103.12	" "
Early Puritan, ...	99.84	" "
Charles Downing, . . .	88.52	" "
Webb's Early, ...	83.97	" "

It is also a noticeable fact that with the exception of Webb's

Early, the per cent. affected by the potato rot of the above-named five varieties is much below the average, the loss from this disease being but two per cent. with the Thorburn and Charles Downing, and but 3 per cent. with Bliss' Triumph, while some varieties, viz., the Potentate, Pearl of Savoy, Early Waterford, etc., show a loss of from 14 to 17 per cent. of the total yield.

It is expected that the following season these investigations will be continued, making the list of varieties somewhat more complete by the addition of other standard kinds which we were unable to obtain for this season's trial, and also by substituting in the place of such varieties as do not warrant further trial here, numerous new varieties, not yet generally introduced, a number of which have been grown at the Station this year but not in sufficient quantities to justify a report of them at this time.

METEOROLOGICAL SUMMARY.

April 1st, 1889, to December 31st, 1889. Records made daily at 7 A. M., 2 P. M., and 9 P. M.

	April.	May.	June.	July.	August.	September.	October.	November.	December.
Highest Barometer	......	30.50	30.38	30.25	30.25	30.35	30.25	30.75	30.60
Lowest Barometer	......	29.40	29.10	29.69	29.63	29.35	29.57	29.20	29.40
Mean Barometer	......	29.87	29.94	29.92	30.02	29.95	29.87	29 85	29.89
Highest Temperature	71 °	88.°	87.°	86.°	82.°	80.°	71.°	62.°	61.°
Lowest Temperature	26.	35.	42.	51.	49.	36.	30.	17.	12.
Mean Temperature	45.9	56.6	64.49	67.7	66.1	61.5	49.2	43.5	38.4
Mean Humidity	.76	.866	.907	.874	.845	.906	.875	.872	.875
Prevailing Winds	N. E.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	W.
Total Rainfall	4.20 in.	3.58 in.	3.66 in.	8.30 in.	4.57 in.	4.61 in.	3.02 in.	7.52 in.	2.76 in.
No. of days on which the cloudiness averaged 8 or more on a scale of 10	7.	6.	14.	14.	10.	13.	10.	11.	8.
No. of days on which the cloudiness averaged 3 or less on a scale of 10	8.	5.	8.	9.	10.	9.	10.	6.	7.
No. of days on which .01 of an inch or more of rain fell	9.	6.	6.	15.	5.	9.	10.	11.	12.

The rainfall from April 1st to December 31st has been 42.27 inches, probably somewhat above the normal, and attended with much cloudy weather and fog along the coast. Pastures were generally reported good during the summer, and the hay crop larger than usual, although the weather was unfavorable for securing it.

Potatoes promised well until the vines blasted during the hot wet weather in July; after that time they rotted badly and with a few exceptions were not a profitable crop throughout the State this season.

Corn started slowly but was a fair crop. In some sections the lower leaves blasted before maturity. Apples were a light crop, having fallen from the trees quite generally during the early part of the season. The smaller fruits and vegetables have with a few exceptions given fair crops.

The mean temperature for November and December was high, probably above the normal, frost remained in the ground but few days in succession. About three inches of snow fell December 14th, but gradually disappeared during the four following days; no other snow storms occurred during the month. With the exception of April and December, southwesterly winds have prevailed during the entire season.

REPORT OF THE DIRECTOR.

CHARLES O. FLAGG.

The agricultural as well as the horticultural division of the station has labored under the disadvantage the past season of cultivating all sward land. The seven and one-half (7½) acres of old sheep-pasture at the west end of the farm, plowed in the fall of '88, being little better than fresh turned sward on account of its "lumpy condition," caused largely by its previous heavy growth of moss. Four acres of oats and spring rye were sown here to furnish a comparison between "drilled" and "broadcasted" grain, and test the benefits of potash salts as a fertilizer. Thirty (30) one-tenth (1-10) acre plots (each four (4) rods square) and each surrounded on all sides by a space five (5) feet in width were accurately marked out. Six (6) of them were planted to "Early Rose" potatoes, differently fertilized, to ascertain if possible what essential elements of fertility were lacking in the soil. With the same idea in mind seventeen (17) adjoining plots were planted with the same variety of white flint corn and fertilized with chemicals alone and mixed in varying proportions. The remaining seven (7) plots were sown to Buckwheat. The results of this work, although not large, teach, we think, some lessons which the experience of another year will, we trust, bring out more forcibly.

Some five (5) acres of buckwheat were sown to furnish a green crop to plow in after having served as a bee pasture.

On June 30th, after the hay had been secured, we commenced plowing about three (3) acres on a part of which one (1) bushel of Japanese Buckwheat was sown with the Empire Grain Drill. It grew very rapidly and ripened a crop which will be used for seed this season. The rest of the field was sown to three varieties of millet, which grew slowly owing to the cool wet weather, and was cut and cured for fodder just before the first frost, Sept. 24th.

During the spring letters were sent to the various granges in the State, asking farmers for samples of the varieties of field-corn grown in their vicinity.

About thirty (30) samples were thus secured. Of those, as far as possible, an equal number of hills containing an equal number of grains were planted in a field equally fertilized throughout, and notes made of the growth and product. Forty-two (42) varieties of sorghum were planted, all germinated with three (3) exceptions, but grew very slowly, owing chiefly, we think, to the wet season, and but a fraction of the varieties threw up seed-heads. Three (3) varieties of Lupines, one (1) of English Horse Beans and one (1) of Pearl Millet made a vigorous growth, the latter being very thick and seven (7) feet high.

About three (3) acres of corn were planted east of the hay barn without any fertilizer in order to see just what the result would be without manure of any kind. Along an old fence row the growth was fairly good, but the lighter portion of the field produced very little sound corn.

One half (½) acre of plain land was plowed, dressed liberally with fine bone and devoted to the nursery, and an acre or more northeast of the farm barn was thoroughly cleared from stone, dressed with stable manure and fertilizers and used by the Horticultural division as a vegetable garden. Rather more than an acre

of the pasture south of the farm-house had the stone thoroughly removed and was used for conducting the test of varieties of potatoes. The balance of the fields have been in grass, producing a moderate crop of hay only, which by the use of hay-caps was secured in fair condition in spite of the *fifteen rainy days* in July. All the fields produce hay of a short, fine growth, commonly called "Burden," in this locality. It is doubtless *Agrostis canina*, and variously known as "Rhode Island Bent," "Brown Bent," &c. It produces a fine nutritious hay for stock feeding, but is not first class "horse-hay." We shall endeavor this season to get a portion of the farm in a condition to produce more palatable hay for our horses.

During the spring and summer a good many rocks were taken out of the northeast field and the pasture east of the Laboratory and used in the cellar walls of that building. The work of filling and grading about the house commenced early in spring, and was continued as opportunity afforded. The old wood-shed and wagon-house were moved away, and the entire space enclosed by the drive-way graded and the gutter turfed. The work was completed so late in the season that seeding was deferred till the coming spring and a liberal top-dressing of coarse manure applied to prevent the soil from washing.

Winter rye was sown on about nine (9) acres, commencing Sept. 7th. Most of it was sown with the Empire Drill. The stand is thin but of good color and promises well. Where sown broadcast a flock of wild pigeons gathered up some of the seed and the stand is even thinner than where drilled in. The various farm machines purchased have given good satisfaction, doing their work well when properly handled. Having but the make of *one* manufacturer in the more important farm machines—grain-drill, sulky-plow, and mowing-machine, we have not been able to make a comparison of relative efficiency.

The agricultural division is now well provided with teams, wagons, tools, &c., most of which have been purchased the past year. The sheds and stable built the past summer are a very desirable improvement, providing comfortable quarters for the horses, oxen, and what other stock we have and shed and storage room for our wagons and tools.

In closing we wish to acknowledge the following

DONATIONS:

April 13th, Hon. N. F. Dixon, of Westerly, presented the Station with a fine Jersey bull calf, about four months old. His pedigree traces to the famous "Stoke Pogis" stock and he promises to make a valuable animal.

Report State Board of Agriculture of Connecticut, 18 volumes, from T. S. Gold, Secretary.

Report State Board of Agriculture of Massachusetts, several volumes, William R. Sessions, Secretary.

Report New York State Board of Health, 9 volumes, from Lewis Balch, M. D., Secretary.

Reports of Agriculture and Arts, Department of Agriculture, Province of Ontario.

Several volumes Reports of the U. S. Signal Service, Department of Agriculture, &c.

Report of the State Board of Agriculture of Kansas and Publications of the Kansas Historical Society.

Reports Ohio State Forestry Bureau.

Reports New York State Entomologist.

Annual Reports and Bulletins of all the Experiment Stations, and newspaper exchanges as follows:

Baltimore Weekly Sun, Baltimore, Md.
Mirror and Farmer, Manchester, N. H.

Western Resources, Lincoln, Neb.

The Farmer's Home, Dayton, Ohio.

Ornamental and Forest Tree Grower, Marinette, Wis.

The Western Rural, Chicago, Ill.

The Grange Visitor, Hope Valley, R. I.

Our Grange Homes, Boston, Mass.

The Southern Cultivator and Dixie Farmer, Atlanta, Ga.

The American Grange Bulletin, Cincinnati, Ohio.

The National Stockman and Farmer, Pittsburg, Pa.

The Cornucopia, Norfolk, Va.

The Sugar Beet, Philadelphia, Pa.

The Agricultural Epitomist, Indianapolis, Ind.

HORTICULTURAL DIVISION.

L. F. KINNEY.

The work in the division during the past season has been mainly of a pioneer nature, much of the land though admirably adapted for horticultural purposes was and is still in a rough and neglected condition. A few pieces only having yet been freed from stone and brought into a state of good cultivation.

Soon after entering upon my duties at the Station a circular letter was issued from the division inviting introducers of *horticultural novelties* to send the Station specimens for trial, stating that plants thus sent would not be propagated beyond the needs of the Station or purposely disseminated without the consent of the introducer. In response to the circular the division received the following donations:

GRAPE VINES.

Name of Donor.	Residence.	Variety.
Bush & Son & Meissner	Bushberg, Mo	2 Montefiore, 2 Mason's Seedling, 2 Etta.
George Horsford	Iona, Mich	1 Berlin, 1 Hosford's Mammoth.
Lewis Rœsch	Fredonia, N. Y.	1 Rutland, 1 Moyer.
Stayman & Black	Leavenworth, Kan	1 Jewel, 1 Standard, 1 Ideal, 1 No. 15, 1 No. 18, 1 No. 19, 1 No. 42, 1 No. 44.
C. Engle	Paw Paw, Mich	1 Michigan, 1 Elaine, 1 Guinerna.

STRAWBERRY PLANTS.

Name of Donor.	Residence.	Variety.
Nouvoo Fruit Growers' Asso'n...	Nouvoo, Ill.............	Lady Rusk.
Stayman & Black.................	Leavenworth, Kan......	Stayman's No. 1. " " 2.
R. Ball.........................	Lyons, Iowa	Clinton.
Edwin King......................	Wooster, Ohio..........	Seedling No. 1. " " 2.
Israel Kinney & Son....	Zanesville, Ohio........	Seedling No. 1.
George A. Rogers....	Upton, Mass............	Roger.

TREES.

Idaho Pear Co....................	Lewiston, Idaho........	1 Idaho pear tree.
E. M. Buechly............	Greenville, O............	Winter Maiden's Blush, (apple scions.)
C. S. Jacobs.................. ...	Medford, Mass..........	Jacobs' Winter Sweet, (apple scions.)
E. W. Daniels	Auroraville, Wis.......	3 Northwestern Greening, (apple.)
O. M. Lord................	Minnesota City, Minn...	2 Rollingston plum trees.

BRIERS.

Dewain Cook	Windom, Minn.........	Windom Dewberry.
R. C. Hart.........................	West Torrington, Conn.	Shaffer's Seedling No. 5, Raspberry.
R. G. Palmer............	Mansfield, O............	Palmer Raspberry. Muskingum Raspberry.

POTATOES.

C. E. Angell......................	Oshkosh, Wis..........	14 varieties.
Iowa Seed Co.....................	Des Moines, Iowa......	Eyeless. Early White Beauty of Hebron. Iowa Beauty.
L. H. Read...	Cabot, Vt...............	Read's 86. Paris Rose. Ben. Harrison.
E. L. Coy..................... ...	West Hebron, N. Y....	Seedling of Peerless.
W. H. Singer & Co................	Cardington, O.........	Austin.
S. Frogner.......	Herman, Minn..........	Seedling No. 50. " " 64.
M. Murray........................	Centre, O...............	Ross.
W. J. Shrop.......................	Rittman, O.............	Louisa.

MISCELLANEOUS.

Name of Donor.	Residence.	Variety.
Dingee & Conard Co	West Grove, Pa	Collection 50 Everblooming Roses.
S. L. Dagwell	Utica, N. Y	Seedling Gooseberry.
Hamlin Johnson & Co	Providence R. I	Collection Dutch bulbs.
Albert K. Underwood	Kingston, R. I	Chinese Wistarea.
Charles E. Brooks, Lib. Worcester Co. Hort. Soc	Worcester, Mass	Set of Transactions of the Worcester Co. Hort. Society from 1847 to 1890.
Garden Publishing Co., L't'd	New York City, N. Y	Copies of Am. Garden for 1889.
Peter Henderson & Co	New York City, N. Y	1 copy Practical Gardening. 1 copy Farm and Garden Topics.

VEGETABLE SEEDS.

W. Atlee Burpee	Philadelphia, Pa	Fifty-five packets.
Peter Henderson & Co.	New York City, N. Y	Twenty "
Northrup, Braslau & Goodwin Co.	Minneapolis, Minn	Eleven "
Iowa Seed Co	Des Moines, Iowa	Twelve "
C. E. Angell	Oshkosh, Wis	Seven "
N. B. Keeney & Sons	Leroy, N. Y	Twenty-one varieties of beans.
J. C. Suffern	Voorhees, Ill	Two packets.
Kendall & Whitney	Portland, Me	" "
Parker & Wood	Boston, Mass	" "
L. H. Read	Cabot, Vt	" "
E. W. Burbank	Fryeburg, Me	" "
Paynter Frame	Harbeson, Del	Three "
Jack Hatt	Argentine, Mich	Two "
Arnold Jenks	Wrentham, Mass	Two varieties of sweet corn.
E. A. Sweet	Kingston, R. I	" " "
J. H. Haskins	Newport, Vt	One packet.
A. W. Nichols	Granville, O	" "
John Lewis Childs	Floral Park, N. Y	" "
A. N. Jones	Leroy, N. Y	" "
Eli W. Gibbins	Barnesville, O	" "
Delano Moore	Presque Isle, Me	" "
H. A. Marsh	Fidalgo, Wash	" "

While conditions over which we had no control so interfered with the results obtained this season from the trial of many of the above novelties, that we do not feel justified at this time in reporting more than the receipt of them, in the future considerable attention will be given to this kind of work. Believing that in so doing we shall promote the horticultural interests of the State, first, by raising the standard, both in quality and quantity, of our crops of fruits and vegetables by aiding in the introduction of superior varieties; and secondly, by checking so far as possible the dissemination of worthless kinds and those not adapted to this locality.

In order that the newer varieties may readily be compared with the kinds now under cultivation, specimens of the latter have been obtained from reliable sources and will be used as standards by which the merits of the novelties of the various classes will be judged. There is now in the nursery to be planted for this purpose, large collections of apple, pear, peach, plum, cherry, apricot and nectarine trees, also grape vines for a specimen vineyard. The smaller fruits such as blackberries, raspberries, currants, gooseberries, strawberries, etc., have already been moved to permanent quarters. In addition to the fruit trees there has been planted in the nursery during the past season some eight thousand seedling forest trees, to be used later upon the station grounds for wind breaks, groves, planting along avenues, etc. While the list includes seventy-two species of trees, only the Black Walnut, Pines, White Ash and Maples will be set out in quantity for forestry purposes.

The experiment with potatoes, consisting of a test of varieties and methods, and also a summary of the meteorological observations made at the station, beginning April 1st and ending December 31st, 1889, is given in detail elsewhere in this report.

A collection of seeds is being prepared for reference. It now

numbers about one hundred varieties and it is hoped that it may be expanded until it includes seeds of all the useful plants as well as the noxious weeds, indigenous or naturalized, within the State.

A temporary propagating pit, 40 ft. long by 11½ feet wide, has been built for the use of the division. There is now growing in the pit about two thousand herbaceous and woody plants, largely vegetable and bedding plants, to be used on the premises during the coming season.

NEEDS OF THE DIVISION.

While the province of horticulture is at present understood to deal more directly with the very practical matters of originating, improving and perpetuating garden plants, yet the questions that belong to gardening belong as well to the department of applied botany, and for rational solution of many of them we must look to the principles of plant physiology and scientific botany. The structure, food, growth, reproduction and diseases of plants occupy a wide field of research, which, as yet, the practical horticulturists have explored in only a superficial manner. Still, without doubt, principles are involved here that are of the highest importance in the development of the science of horticulture.

For the prosecution of this work the division needs a *horticultural laboratory with a green-house attached*, where plants can be grown from the embryo to maturity under known and controlled conditions, where they can be examined at intervals during their growth under the microscope and other physiological apparatus without impairing the normal functions of growth which are frequently exactly the phases of life that it is desired to study. In conclusion, I wish, therefore, to emphatically urge that a building for *laboratory and green-house purposes* be erected at as early a date as possible, sincerely believing that such a building is of vital importance to the progressive work of the division.

CHEMICAL DIVISION.

H. J. WHEELER.

Since the Chemical Laboratory of the Experiment Station is not yet completed, my report for the division is necessarily brief.

Toward the close of February, 1889, I received a communication from the President of the Board of Managers of the Station in relation to the position of Chemist. Being in Göttingen, Germany, at the time, the correspondence naturally progressed slowly, and it was not until the beginning of April that I received the official notification of my appointment as chemist to the Station. At the same time I was informed that the Board of Managers desired me to purchase in Germany the necessary outfit for the Chemical Laboratory and also such books and journals as I deemed essential to the equipment of the Station library. I reported to the Board that I could use $2,200 to advantage for the above mentioned purposes; in the reply the sum of $2,000 was placed at my disposal.

About $500 was expended in the purchase of books and journals, in all about two hundred and fifty bound volumes.

The remainder of the sum, i. e., about $1,500, was devoted to the purchase of a first-class microscope, one polarization apparatus for sugar analysis, one large and two small analytical balances, made by Sartorius of Göttingen, about $100 worth each of platinum dishes and crucibles, a combustion furnace, about one hun-

dred and fifty reagent bottles, a large stock of the best filter paper, also thermometers, hydrometers and about thirteen hundred miscellaneous pieces of glassware, besides wooden and iron-ware and the necessary supply of porcelain.

Since many of these articles could only be purchased in Germany agents' commissions were thus avoided.

The apparatus being intended for scientific purposes *was also admitted to this country free of duty, which allowed of the purchase of a much larger outfit* than could have been bought from the dealers in New York for the same sum.

In order to more fully acquaint myself with the work of some of the European Experiment Stations before my return to America, I visited the Agricultural Experiment Stations at Zurich, in Switzerland, also those of Darmstadt, Bonn, Hildesheim, Bernburg, Möckern, Halle, Göttingen, and Berlin, in Germany, and also the Rothamstead Station at Harpenden, England, conducted by Sir John B. Lawes and Dr. Gilbert and supported by the former as a private enterprise. I also visited the iron phosphate works at Peine and Ilseda and the celebrated potash mines at Stassfurt.

The "Consolidirte Alkaliwerke," in Westeregeln, near Stassfurt, had the kindness in response to my suggestion, to present to the Rhode Island State Agricultural School and Experiment Station a complete collection of the crude and manufactured products of the potash mines. These will be placed on exhibition in the museum of the Station.

My official duties at the Station began September 1, since which date I have been variously employed while awaiting the completion of the laboratory, at which time the legitimate work of the Division will begin. Among other work I have been employed in indexing the publications of the Agricultural Experiment Stations of the United States, in order that the facts might be available in connection with the future work of the Station, also in collecting

and completing, so far as possible, for library purposes, such Bulletins and Reports as have already been issued by the other stations. I have also been called upon to assist the Director in connection with the purchase of a gas machine, heating apparatus, etc., and in the general correspondence of the Station, and have written one bulletin on "Stock Feeding."

The L. B. Darling Fertilizer Co., of Pawtucket, have kindly placed at my disposal the use of their chemical laboratory with gas, until the laboratory at Kingston shall be completed; here, I am now engaged in doing such preliminary work for the Station as the immediate needs demand.

Since the new laboratory of the Station is now rapidly approaching completion, there is every reason to hope that the work of the Division will soon be in active progress.

APIARIAN DIVISON.

SAMUEL CUSHMAN.

An account of the work of this Division up to the close of the season is given in Bulletin No. 4, on page 90, under the head of "Report of the Apiarist." For a general list of the property of this Division see Appendix.

It is hoped that facilities for more extended work may be given this Division. Much may be done that will give immediate results of practical value to the bee keepers of the State and country.

The work already commenced, the increasing correspondence and the interest of visitors make desirable the more constaht attendance at the apiary of the person in charge than has been possible the past season.

REPORT OF THE TREASURER.

The Agricultural Experiment Station of the Rhode Island State Agricultural School in Account with the United States.

Dr.

July 1st, 1888, to June 30th, 1889.—

To cash received from the Treasurer of the United States as per appropriation for the fiscal year ending June 30th	$15,000 00
	$15,000 00

Cr.

By Salaries	$1,602 17
" Labor	1,947 56
" Supplies and Repairs	1,244 74
" Freight, Express, Postage and Stationery	136 18
" Library and Printing	553 26
" Tools and Machinery	2,070 76
" Scientific Instruments	554 84
" Chemical Apparatus and Supplies	1,437 11
" Furniture and General Fittings	113 51
" Roads, Water Supply and Drainage	1,464 15
" Live stock	729 31
" Traveling	126 51
" Buildings	3,000 00
" Incidentals	19 90
	$15,000 00

This certifies that we, the undersigned authorized Auditing Committee of the Board of Managers of the Rhode Island State Agricultural School and Experiment Station, have examined the accounts of the Treasurer of the Agricultural Experiment Station

for the fiscal year ending June 30, 1889, and that we find the receipts for the time named to have been $15,000, and that the same has been expended, for which satisfactory vouchers, correctly classified as above, are on file, and the same agrees with the Treasurer's account, that $3,000 and no more has been expended for buildings and that there is no unexpended balance.

CHANDLER H. COGGESHALL,
CHARLES J. GREENE,
CHRIS. A. SHIPPEE,
Auditing Committee.

I hereby certify that the above statement is a true copy from the books of account of the Institution named.

MELVILLE BULL,
Treasurer of the Rhode Island State Agricultural School and Experiment Station.

I hereby certify that the above signature is that of the Treasurer of the Rhode Island State Agricultural School and Experiment Station.

CHARLES O. FLAGG,
President Board of Managers Rhode Island State Agricultural School and Experiment Station.

APPENDIX.

LIST OF APPARATUS AND BOOKS PURCHASED FOR THE CHEMICAL DIVISION.

But comparatively few of the books here referred to are strictly chemical, they were selected as special works of reference for the working library of the Station, and in connection with stock feeding experiments are many of them, indispensable.

Books, about 250 bound volumes.
1 soil-testing apparatus.
1 microscope with six objectives and a microphotographic apparatus.
1300–1400 single pieces of glass apparatus. A supply of glass tubing of all sizes.
2 mills for preparing fodder samples for analysis.
1 short-armed Sartorius, 200 gr. analytical balance.
2 short-armed Sartorius, 2000 gr. analytical balances.
3 sets of weights for the above-mentioned balances.
1 Westphal balance for specific gravity determinations.
141 glass stopped reagent bottles.
1 combustion furnace for elementary analysis.
4 plain platinum crucibles.
8 platinum crucibles, after Gooch.
8 platinum evaporating dishes.
1 1-5 reams of filter paper.
2 gasometers.
1 agate mortar.
1 half-shadow polarization apparatus, after Laurent, for sugar analysis.
80 pieces of miscellaneous porcelain ware, including evaporating dishes, crucibles, funnels, spatulas, &c.
70 pieces of special iron ware, including retort holders, iron stands, collars, rings, burette holders, etc.

The following is a general list of the live stock, wagons, tools and machinery, scientific instruments and apparatus, trees, shrubs and plants, bee hives, &c., purchased for the use of the Station :

16

FARM.

1 pair draft horses, 8 years old.
1 cart horse, "Jim," 6 years old.
1 driving horse, "Dandy," 5 years old.
1 pair oxen.
1 Jersey bull, 1 year old.
1 grade Jersey cow, 5 years old.
1 grade Guernsey calf.
2 sets double harness.
1 heavy farm harness.
1 cart harness.
1 Sherwood harness.
1 light express harness.
6 feed bags, blankets and stable tools.
1 two-horse team wagon.
1 two-horse cart.
1 ox cart.
1 one-horse cart.
1 one-horse farm wagon.
1 two-horse lowgear.
1 express wagon
2 wagon-jacks, oil cups, wrenches, &c.
2 ox-yokes.
1 10-tube Empire grain drill.
1 Syracuse sulky-swivel plow.
1 heavy-swivel plow.
1 subsoil plow.
1 furrow plow.
1 Clark's cutaway harrow.
1 Acme No. 10 harrow, with sulky.
1 Evans smoothing harrow.
1 Breed's weeder.
1 Planet, Jr., horse hoe.
1 Ajax cultivator.
1 two-horse iron roller.
1 hand iron roller.
1 ox shovel.
1 wheelbarrow.
4 earth barrows.
14 shovels.
6 hoes.
2 spades.
5 picks.
4 mattocks.
4 iron rakes.
3 potato hooks.
1 Fish corn planter.
1 Buckeye mowing machine, 6 ft. cut.
1 Tiger horse rake.
1 hay and stalk cutter.
6 hand rakes, scythes, forks, axes, bush hooks, baskets, &c.
1 38-foot extension ladder.
1 18-foot ladder.
1 grindstone.
100 Symms pulp hay caps.
1 windlass with rope and blocks for derrick.
1 giant stone puller and Sampson gear.
8 steel bars, striking and hand hammers, drills, chains, &c.
2 stone boats and drag plank.
1 portable forge.
1 anvil and 1 iron vise.
1 chest carpenter's tools.
1 portable platform scale.
1 spring balance.
1 steel tape.
1 Buff & Berger transit, with solid silver graduations, leveling rod, sighting pole, and 100-foot measuring chain.
2 office desks and fittings.

HORTICULTURAL DIVISION.

Meteorological Apparatus.

1 Green's standard barometer.
1 Green's standard rain-guage.
1 standard hygrometer.
1 standard maximum thermometer.
1 standard minimum thermometer.
1 weather vane.

Tools, Apparatus, &c.

1 "New Model" lawn mower.
2 wheel hoes.
1 "New Model" seed drill.
1 "Perfection" spraying outfit.
1 Waters' pruning hook.
1 pair pruning shears.
2 Woodason's insect bellows.
1 "Farmer's Favorite Potato-bug Exterminator."
2 Fairbanks' scales.
50 feet ¾ inch rubber hose.
20 hot-bed sash and shutters.
4 straw mats.
2,000 painted wooden stakes.
1,000 glass specimen tubes.
29 glass funnels.
6 plain standard thermometers.
2 soil thermometers.
2 compound microscopes, with accessories.
1 dissecting microscope.
1 turn-table.
1 section cutter.

Standard Fruit Trees, 325 Varieties.

125 apple trees.
56 pear trees.
45 plum trees.
45 peach trees.
29 cherry trees.
12 apricot trees.
12 nectarine trees.
3 fig trees.

Small Fruits, 82 Varieties.

30 varieties of strawberries.
17 " " raspberries.
17 " " blackberries.
18 " " gooseberries and currants.

One Hundred and Thirty Ornamental Trees and Shrubs.

50 ornamental trees.
80 ornamental shrubs.

Eight Thousand Seedling Forest and Ornamental Trees.

1,350	seedling	pines.
1,000	"	black walnut.
1,500	"	larch.
1,000	"	white ash.
1,000	"	maple.
500	"	arbor vitae.
300	"	hemlock.
250	"	spruce.
100	"	catalpa.
100	"	beech.
100	"	birch.
100	"	elm.
100	"	locust.
50	"	buckthorn.
50	"	hawthorn.
50	"	Spanish chestnut.
50	"	Mahaleb cherry.
50	"	horse chestnut.
350	"	(various kinds.)

Two Thousand Greenhouse Plants.

200 lettuce plants.
300 geranium plants.
300 coleus plants.
300 achyranthus plants.
200 altenanthera plants.
50 nasturtium plants.
50 smilax plants.
50 ever-blooming roses.
200 canna (roots).
25 caladium (roots).
25 heliotrope plants.
300 plants (various kinds).

APIARY.

16 colonies bees, containing
2 imported Carniolan Queens.
1 American bred Cyprian Queen.
6 best American bred Italian Queens.
1 native or common black Queen.
6 Italian and hybrid Queens.
20 R. I. Simplicity Hives.
15 outer cases or winter hives.
Cork packing for same.
1 Root Honey Extractor.
1 Root Sun Wax Extractor.
Platform scales.
1 two burner oil stove.
1 copper teakettle.
2 tin pails.
2 100 quart milk cans with faucets.
2 honey knives.
3 bee smokers.
1 tin comb bucket.
1 copy New Edition of Langstroth on "The Hive and the Honey Bee."
A quantity of wire nails, surplus honey boxes and wire cloth.
Small amount of wax, glue, comb foundation, annealed wire and sugar syrup.
Hammer, hatchet, saw and various knives and other tools.
13 hives of different patterns, for exhibition in Bee Division Museum.

State of Rhode Island and Providence Plantations.

THIRD ANNUAL REPORT

OF THE

BOARD OF MANAGERS

OF THE

Rhode Island State Agricultural School and Experiment Station,

MADE TO THE

GENERAL ASSEMBLY AT ITS JANUARY SESSION, 1891.

PART II.

Rhode Island

STATE AGRICULTURAL EXPERIMENT STATION,

[Part I—State Agricultural School—is printed under separate cover.]

PROVIDENCE, R. I.
E. L. FREEMAN & SON, STATE PRINTERS.
1891.

BOARD OF MANAGERS.

Rhode Island State Agricultural School and Experiment Station.

C. H. Coggeshall,	Bristol County.
Chas. O. Flagg,	Providence County.
Chas. J. Greene,	Washington County.
Melville Bull,	Newport County.
Jas. H. Eldredge,	Kent County.

OFFICERS OF THE BOARD.

Chas. O. Flagg, President,	P. O., Kingston, R. I.
Chas. J. Greene, Secretary,	P. O., Kenyon, R. I.
Melville Bull, Treasurer,	P. O., Newport, R. I.

STATION STAFF.

Chas. O. Flagg, B. Sc.,	Director and Agriculturist.
L. F. Kinney, B. Sc.,	Horticulturist.
H. J. Wheeler, Ph. D., (Göttingen),	Chemist.
Samuel Cushman,	Apiarist.
F. E. Rice, M.D., M.R.C.V.S.,	Veterinarian.
H. F. Adams,	Farmer.
Miss A. R. French,	Clerk.

The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office, Kingston, Rhode Island.

REPORT.

To His Excellency, John W. Davis, Governor, and the Honorable the General Assembly of the State of Rhode Island, at its January Session, 1891:

KINGSTON, Jan. 26th.

The Board of Managers of the Rhode Island State Agricultural School and Experiment Station submit their Third Annual Report in two parts, the first being a report of the State Agricultural School and the second of the State Agricultural Experiment Station.

In the August, 1890, issue of the U. S. Postal Guide is found the following in reference to the mailing of the reports of the Experiment Stations: "If such station's annual reports be printed by State authority and consist in part of matter relating to the Land Grant College to which such station is attached, the said report may be mailed free entire by the director of the station, provided in his judgment the whole consists of useful information of an agricultural character." It is thus evident that were our State Agricultural School established in accordance with the conditions of the Land Grant Act of 1862, our report instead of being divided as is now necessary could be published under one cover and mailed free to every farmer in the State.

Last year the annual report included all the bulletins published during the year, but as both are sent to the same list of addresses

it is thought more economical, as there is considerable unpublished matter relating to the year's work—to give only a synopsis of each of the four bulletins issued for the year ending December 31st, 1890.

No. 6. March. Covered twenty-four pages. This was in the interests of the dairymen and contained a concise description of the causes and symptoms of the disease known as Milk Fever or Parturient Apoplexy in cows. It gives a concise account of its history, causes, symptoms, treatment, effect on cow's flesh as food, etc., by F. E. Rice, M. D., M. R. C.V.S.

No. 7. June. Covered forty pages. This contains a catalogue of the varieties of large and small fruits set in the orchards and garden of the station, with a description of each, time of ripening of fruit, etc. Also a meteorological summary for the six months ending with June 30, 1890, by L. F. Kinney, horticulturist.

Also a report upon the management of the Apiary, embracing the subjects; Results of Wintering Bees Outside and in the Cellar-Spring Management and Dry Sugar Feeding, by Samuel Cushman, Apiarist.

No. 8. September. Covers thirty-four pages and treats of soils and fertilizers under the following topics: (*a*) Soils, their Origin, Analysis and Renovation. (*b*) Agricultural Chemicals and their use. (*c*) Commercial Valuation of Fertilizers. (*d*) Composition of Fertilizing Materials, by H. J. Wheeler, Ph.D., Chemist.

No. 9. December. Includes twenty-four pages, and treats of the following experiments in Apiculture: (*a*) Artificial Heat for Promoting Brood Rearing. (*b*) Hive on Scales and Sources of Honey. (*c*) Carniolan bees; also a discussion of the contagious disease known as Foul Boood, its cause, prevention and cure, by Samuel Cushman, Apiarist.

Four thousand copies of each bulletin have been published, more than three-fourths of which have already been sent out and applica-

tions for them are received almost daily. Any person in the State interested in agriculture and not now receiving our bulletins can have them free of cost upon application.

At the date of the original organization of the Board of Managers of the Rhode Island State Agricultural School and Experiment Station, July 30th, 1888, the limit of time in which the first annual payment to the various states under the "Hatch Act" was made, had expired; the limit being the close of the United States fiscal year, June 30th, and according to the conditions of the act the payment had reverted to the United States Treasury. The Board well knowing that the failure to secure the first payment of $15,000 was due to the delay caused by the time necessarily taken in the legal establishment of the School and Station and that all the other States had received their first payment, consulted those familiar with the Experiment Station movement, and the Senators and Representatives in Congress from this State, in reference to the recovery, through a special act of Congress, of the $15,000 which had reverted. It was a just claim and received the unanimous support of our Congressmen—Senators Aldrich and Dixon and Representatives Arnold and Spooner—and through their influence the following amendment was made to the "Urgent Deficiency Bill":

"To enable the Secretary of the Treasury to pay to the State of Rhode Island the sum which said State would have been entitled to receive under the provisions of an act entitled "An act making an appropriation to carry into effect the provisions of an act approved March second, eighteen hundred and eighty-seven" and so forth, approved February first, eighteen hundred and eighty-eight, if the agricultural experiment station in said State had been organized within the time required by the said act approved March second, eighteen hundred and eighty-seven, fifteen thousand dollars."

This bill was passed by Congress on April 4th, 1890. The necessary papers were drawn up by the Board and on the 24th of

May the Treasurer received the amount of the special appropriation. As the account of the Treasurer closes with the United States fiscal year, June 30th, this special appropriation appears as cash. The Board desire to use a portion of it in the purchase of thoroughbred stock as soon as a suitable stock and dairy barn is provided. It will also furnish the means to organize the Poultry Division, to purchase books which are necessary for use in the various divisions, scientific apparatus, etc.

During the year past, the Laboratory has been completed, although little work could be done by the Chemist until the completion of the water supply about October 1st. The artesian well with windmill and tank furnish an abundant supply of good water. At times during the fall when the pump was not running the water flowed over the top of the well and at its lowest is less than three feet below the top of the well. Water pipes have been laid to the farm house and the barn and stables, a desirable improvement over the previous water supply.

At the May session of the Assembly, Dr. James H. Eldredge, of East Greenwich, was appointed a member of the Board of Managers to succeed the member from Kent County whose term expired in June. At the annual meeting of the Board the office of Secretary, previously united to that of Treasurer, was separated from it, owing to the increased labor attendant upon the growth of the School and Station, and Mr. Chas. J. Greene appointed to that office. The Board in the discharge of their duties have held fifteen meetings during the year.

We have the pleasure to transmit herewith the report of the Director of the Station; the results of the Co-operative field experiments, and report of the Chemical Division by Dr. H. J. Wheeler; results of the experiments with potatoes and report of the Horticultural Division and Meteorological Summary for the year ending December 31st, 1890, by Prof. L. F. Kinney; report of the Api-

arian Division by Mr. Samuel Cushman, and the annual report of the Treasurer, Hon. Melville Bull, as required by law.

Respectfully submitted by the Board of Managers,

CHARLES O. FLAGG, *President.*

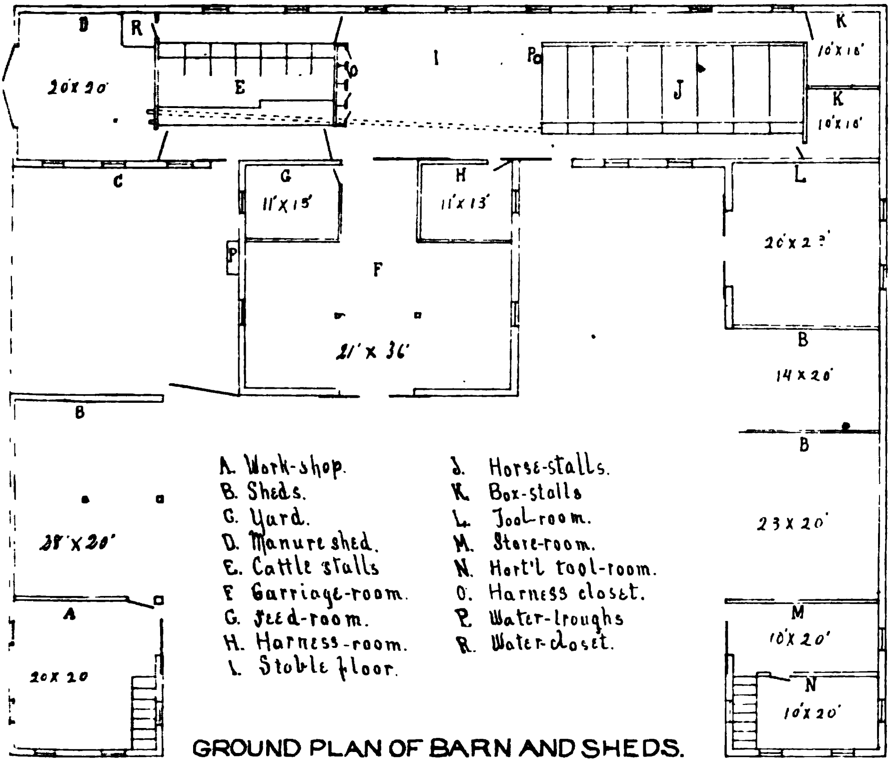
REPORT OF THE DIRECTOR.

CHARLES O. FLAGG.

Early in the season of 1890 it was decided to undertake a series of co-operative field experiments with corn, using agricultural chemicals for fertilizers and cultivating duplicate fields in several sections of the State. As the time of the director was fully occupied with the details of other work, and the Laboratory was at that time incomplete, the oversight of this series of experiments was delegated to the Station Chemist, Dr. H. J. Wheeler and a detailed report of the results of one season's work, as compiled by him immediately follows this report. We desire to acknowledge our indebtedness to the farmers who have generously assisted in this work, for the care and interest they have manifested and the effort made to obtain as far as possible, correct results.

FARM IMPLEMENTS.

The sheds and stables were externally complete when we made our last report; since then they have been finished on the interior and put into practical use for the accommodation of our teams and tools. A good idea of the internal arrangement can be obtained from the accompanying plan. The portion occupied by the stable and extending the length of the north side has a "concrete" floor made of stone, tar, gravel and asphaltum. This at first was indented by anything standing upon it for a few hours—but after



GROUND PLAN OF BARN AND SHEDS.

a few months became hard. The carriage room, feed room, tool room, carpenter's shop and Horticultural tool room, are floored with cement concrete. Water from the artesian well is brought into the stable for the horses, to the carriage room for washing wagons and to a tub in the yard for cattle. Early in the summer, the farm buildings were thoroughly painted with two coats of lead and oil, a light yellow color with white trimmings; this in addition to the seeding of the grounds around the farm house and the setting of trees and shrubs has improved the appearance of the farm buildings. As last season, a considerable portion of the time of the farm help and teams under the direction of the Farmer, Mr. H. F. Adams, has been devoted to getting out rocks

in the vicinity of the new school buildings and Veterinary Hospital, and from the grounds devoted to the Horticultural Division. Tile drains have been laid in most of the trench dug for laying the water pipes—to remove the excess of water in the spring of the year and save the expense of digging ditches especially for draining.

The grounds around the Laboratory have been partially graded and the construction of walks and driveway is well advanced, to be completed at an early day. During the spring the highway laid out by the authority of the Town across the westerly portion of the farm toward the Chippuxet bridge, was "turnpiked" by plowing and scraping. It is desirable to connect with this roadway by continuing the driveway already constructed from the farm house to the highway.

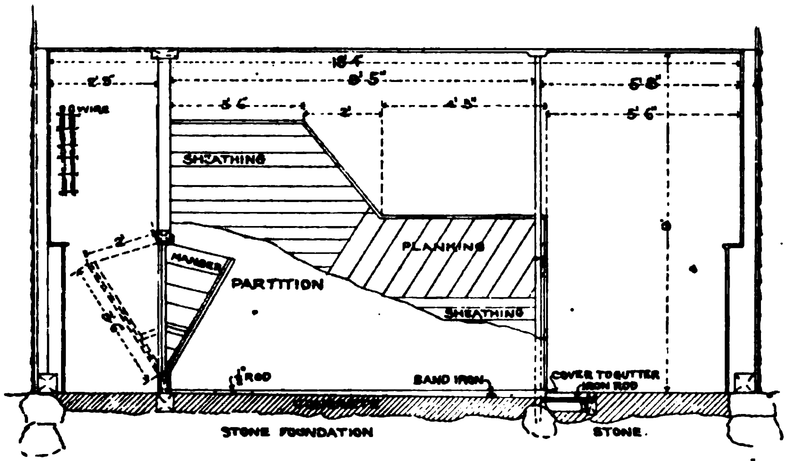
STABLE FITTINGS.

The concrete floor of the horse stalls slopes two inches toward the rear, where there is a gutter of concrete with drains to the manure cellar. The floor of the stall is covered by a movable rack made of pieces of spruce 4 x 4 inches at the rear end and 4 x 2 inches at the front end so that the horse stands on a level surface. These pieces are held in place by a half inch iron rod which passes through them about two feet from the front end; a piece of ½ inch board keeping the pieces that distance apart. At the rear end each one is nailed to a piece of 1½ inch band iron. This leaves a clear ½ inch space between each two pieces, so that a hook can be easily and quickly used for cleaning the racks. A notch is cut at the rear end to fit over the plank which covers the gutter and the rack is thus held in place. This rack can be removed at a moment's notice at any time for repairs, or to allow earth to be placed in a stall for a horse to stand upon.

The partitions of the stalls are held in place at the rear by a gas

pipe set on a stone in the concrete floor and extending to the ceiling; the center of the partition is of plank with ⅞ inch sheathing on each side. ' Finished in this way there is no projection against which a horse can kick.

The crib is made of wood V shaped and hung by T hinges at the bottom so that it can be pulled forward out of the stall when the horse is being fed, or at night, leaving a perpendicular surface for the front of the stall. That part of the front partition above the top of the crib is made of strong galvanized wire fencing as illustrated in the cut giving a section of a horse-stall. This is much better than a close partition, as it gives the horse better air and he can be seen by any one in the passageway and is less likely to be startled by the sudden pulling out of the manger. The cut in addition to the description will fully illustrate the method of construction.



PLAN OF STALLS.

CATTLE TIES.

The following kinds of cattle ties were used:

1st. The Chain Hanging Cattle Stanchion—a swing stanchion held in place by a few links of chain at top and bottom.

2d. The Straight Prescott Stanchion is a swivel stanchion, turning upon an iron at the centre of the top and bottom but has no forward or backward motion as does the Chain Stanchion.

3d. The "Bent Prescott Stanchion" is hung in the same way as the Straight Stanchion but is so made, by being bent toward the rear, that the animal when standing is forced back about six inches and is intended to give the animal more room for the shoulders in getting up.

4th. The Newton Improved Cow Tie made at Batavia, Illinois. This is made of a stick of wood 1½ inches in diameter and 7 feet 9½ inches long, the two ends bent at right angles with the middle portion which is about 3 feet long or varying according to the width of the stall. Partitions are to be made in the mangers between each two animals and bolts pass through the ends of this bent stick and the partition, some 2½ feet from the floor, but at such a distance in front of the line of the stanchion sill that the straight middle portion will rest on the stanchion sill when the animal is lying down. In the center of this is placed a malleable iron band, in which is a swivel to which is attached a rope tie with metal clasps adjustable to the size of the neck of the animal. The rope tie goes around the animal's neck and the huge wooden bale is held close up under the neck. The animal can turn the head freely but cannot get very far forward or back or to either side of its stall. This tie requires partitions in the manger in order to fasten it in place and has the merit of being adjustable to large or small cattle.

Of the four kinds of ties, we believe No. 1 ranks first in durability, convenience and value, and No. 4 second, with the advantage of adjustability to various sizes of cattle.

CROPS AND FIELD EXPERIMENTS.

RYE.

At the west end of the Plain, rye had been sown in the fall of '89 upon what had been a portion of the old sheep pasture and was in so exhausted a condition that there was not sufficient grass to pay for cutting. In the spring of '89 four acres was sown to oats and spring rye, one-half of each broadcast and the other half drilled in with the Empire drill. 200 lbs. per acre of Darling's fine ground bone was drilled in with the seed, and on the plots sown broadcast, the same quantity of fertilizer was put on with the drill before the seed was sown. The plots lay side by side, running east and west, and were divided in halves north and south and the east end of all the plots received a dressing of 100 lbs. per acre of muriate of potash. The seed came up well but made a spindling growth and neither rye or oats was ever worth cutting. The spring rye produced heads about 1½ inches long on straws 2½ feet high without grain, and as far as could be determined by the eye or measurements in height, there was no difference in the growth between the portion to which the potash was applied and that which received the bone only, or between the drilled and broadcast plots.

In June, four and a half acres adjoining were sown to buckwheat without fertilizer or manure of any kind and made a fair growth of stalk. One-half acre just north of the oat and rye plots was divided into five one-tenth acre plots each of which was treated with chemicals or manure and sown to buckwheat. As the whole field was so evidently deficient in vegetable matter, or humus, the entire field was plowed about September 1st, '89, with a sulky swivel plow and the oats, rye, buckwheat and weeds, which had made a feeble growth in the slender growth of grain, were plowed

in and completely covered from five to six inches deep and winter rye drilled September 7th, '89, upon the field.

The portion upon which buckwheat had been grown and plowed in without manure, produced a very thin stand, and where sown broadcast was much thinner than where drilled. The best portion of the grain was on that part of the field where the oats and rye were sown the previous season. The straw was of good height and very even and the heads of uniform length and well filled, the stand, however, was thin excepting on the plots Nos. 27 and 29 on which stable manure and seaweed were applied. These received the same amount of seed but the plants "tillered" so that the grain was more than twice as thick as any other part of the field. The grain was cut on July 10th, with a "Wood" Reaper. An average spot of exactly 100 square feet was selected from each plot, carefully cut, cured, threshed and weighed and the results calculated to yield per acre, are given in the following table. To obtain the value of the crop, the straw is estimated at twelve dollars per ton and the grain at seventy-five cents per bushel. The plot to which phosphate alone was applied, was cut into by a highway and is therefore left out.

YIELD OF RYE PER ACRE.

Plot.	Fertilizer.	Quantity.	Value.	Tons of Straw.	Bushels of Rye.	Value of Crop.
26	Muriate of Potash......	160 lbs ..	$ 3 84	2.64	9.48	$38 79
27	Stable Manure.........	6 cords ..	40 00	3.83	37.27	73 91
28	Nothing...............	....	....	2.42	3.88	31 85
29	Seaweed...............	10 cords..	40 00	3.36	25.03	59 09
30	Sulphate of Potash	160 lbs...	2 74	2.33	7.29	33 42
Field	Mixed Chemicals.......	500 lbs...	9 00	2.96	17.98	49 00

It will be seen from the above table that the plots to which potash was applied, Nos. 26 and 30 produced in one instance more straw than the "nothing plot" and in the other a little less, while

the potash increased the yield of grain two or three fold. As the cost of seed and labor to the time of harvesting was the same for all the plots, and the labor would only increase in proportion to the increase in the crop, we estimate the greatest profit was in the field crop. Other experiments in the vicinity, however, indicate the lack of phosphoric acid in the soil and a direct application of that element *might have given* even greater profit than the field crop.

Quite a series of plots cultivated for two years in corn have this fall been sown to rye and more complete results are expected next season. We believe, that with a good press for baling the straw, rye can be profitably grown in this section of the State.

OATS.

A portion of the field planted in '89 to corn without manure, and on which the crop was very small, was plowed April 16th, as deep as the thin soil would allow without turning up subsoil. Harrowed April 23d, with the "Cutaway" and once with the Smoothing harrow to put the ground in good condition. Nine plots of one-fourth acre each, were laid off and on each of the first four plots 233¾ lbs. of "Earle's" Horsefoot Guano (sent to the Station for trial), guaranteed to contain 1.5 to 2.5 per cent. of nitrogen, 6 to 10 per cent. of phosphoric acid and 2 to 4 per cent. of potash was applied with the grain drill. Plots 5 and 6 received no fertilizer. Plots 7, 8 and 9 each received 219 lbs. of mixed chemicals, making the value equal to the cost of the Horsefoot Guano ($14.02) per acre. This required 74 lbs. of muriate of potash, 100 lbs. nitrate of soda, 403 lbs. of dissolved bone, 100 lbs. of fine ground bone, 100 lbs. of tankage and 100 lbs. of sulphate of ammonia. This mixture at the same cost, furnished approximately 11.5 lbs. more of phosphoric acid, 29.6 lbs. more of nitrogen and an equal amount of potash, allowing that the Guano contained the full amount of

the higher guarantee which commercial fertilizers seldom reach. In fact, if analysis shows the fertilizer to equal the lower guarantee the conditions of the law are discharged, hence it is always safe for the farmer to estimate on the lower guarantee in calculating the value. The field was plowed April 16th, and seeded April 23d and 26th. A thick growth of "Charlock" (Brassica sinapistrum) came up in June and the field presented a dense mass of yellow bloom, completely hiding the oats. Many fields in this section are thoroughly infested with this weed. The weeds were pulled from among the grain as carefully as possible but considerable injury was done the crop by the weeds and in the removal of them.

Plots 1, 2 and 9 were sown with "Bonanza" oats procured of B. L. Bragg & Co., of Springfield, and were a portion of the American Agricultural prize crop of 135 bushels per acre. The seed was very plump and weighed 36 pounds to the measured bushel. The other plots were sown with "New York State Seed Oats" purchased of a grain dealer, and weighed 30 pounds to the measured bushel.

Plots 5 and 6 received no fertilizer and produced almost nothing. What grain there was did not ripen until August 7th, a week after the other plots were cut.

Plots 7 and 8 were sown with a mixture of 24 pounds of oats and 29 pounds of Canada peas, yellow peas being used on one plot and green peas on the other. There was apparently no difference in the growth and both plots were cut for fodder July 24th. The peas were sown on the furrow and the ridges worked down with the smoothing harrow, when the oats were sown broadcast and harrowed in.

On plots 1, 3 and 5 the seed was sown with the Empire Drill and on plots 2, 4 and 6 it was sown broadcast and covered with the smoothing harrow. The same seed sown broadcast came up at least one day sooner than when drilled.

EXPERIMENT WITH OATS.

Plot.	Fertilizer per Acre. Kind.	Quantity.	Cost.	Variety of seed sown.	Method of sowing.	Pounds of seed sown per acre.	Crop per Acre. Pounds of Oats.	Pounds of Straw.
1	Earle's Horsefoot Guano..	935 lbs.	$14 02	Bonanza.........	Drilled	96 lbs...	422	1810
2	" " "	935 "	14 02	"	Broadcast.	96 "	388	1592
3	" " "	935 "	14 02	New York State.	Drilled....	96 "	456	1344
4	" " "	935 "	14 02	" " "	Broadcast.	96 "	416	1312
5	Nothing....................	....	......	" " "	Drilled	96 " ...	92	412
6	"	....	......	" " "	Broadcast.	96 "	64	308
7	Mixed Chemicals.........	877 lbs.	14 02	York State.. / Yellow peas.	"	96 lbs. / 116 "	....	......
8	" "	877 "	14 02	York State.. / Green peas..	"	96 " / 116 "	....	......
9	" "	877 "	14 02	Bonanza.........	"	96 lbs....	560	1492

CONCLUSIONS.

As to variety of oats. The New York State Oats gave better results as to grain but less straw than the "Bonanza," the latter being about three inches taller than the former.

As to method of sowing.—The average of the "drilled" plots was 323½ pounds of oats and 1188⅔ pounds of straw as against 289⅓ pounds of oats and 1070⅔ pounds of straw, *or 11 per cent. more grain and just a fraction less than 11 per cent. more straw on the plots where the seed was sown with the Empire Drill.*

As to Fertilizers.—We can only compare plot 4 with plot 9 where the conditions were equal as to variety of seed and method of sowing. Here we find that *mixed chemicals at the same cost gave 34.6 per cent. more grain and 13.7 per cent. more straw than Earle's Horsefoot Guano.*

CORN.

In 1889, a portion of the old sheep pasture was plowed and laid out in plots, exactly four rods square, containing one-tenth of an acre each. Five rows of plots with six plots in a row were laid out. The plots were separated by pathways five feet in width running each way at right angles. The first row of plots on the north was planted to potatoes. The second, third and fourth rows were planted to an eight rowed variety of white flint field corn, and the fifth row was sown to buckwheat and later to rye and under that heading the report may be found.

Of the 18 plots planted with corn, No. 19 was divided by a roadway being laid out across it and hence it is dropped out of the table. Plots 9, 15 and 21 received at the rate of six cords of horse manure (straw used as bedding) per acre in both 1889 and 1890. This was applied during the winter and spread immediately on the surface. Plots 11, 17 and 23 received at the rate of ten cords of seaweed per acre in 1889, applied in the same way. In 1890, seaweed was difficult to obtain and these plots received only the chemicals as stated in the table. After the plots had been plowed and well harrowed and just before planting, the chemicals were carefully weighed, applied by hand broadcast to the surface and lightly worked into the soil with a cultivator.

The corn was planted in hills three feet apart each way. In 1889, the ground was plowed to a depth of seven inches, May 5th to 12th, worked with Cutaway, Acme and smoothing harrows. Chemicals applied and planted May 24th. The cultivation was shallow—the surface stirred to the depth of two inches June 15th, 22d and August 7, and the plots hoed by hand June 17th, 24th and August 10th. The crop was cut up on September 21st and husked and weighed November 16th. The chemicals applied and the weight of corn and stover, calculated to amount per acre, is shown by the table for 1889.

FERTILIZER EXPERIMENT WITH CORN—1889.

Plot.	Fertilizer Applied per Acre. Kind.	Quantity.	Cost.	Yield of Corn per Acre. Pounds of Ears.	Pounds of Stover.
7	Bone Black	320 lbs...	$ 4 16	750	760
8	Muriate of Potash	160 " ...	3 84	470	540
9	Stable Manure	6 cords...	40 00	2965	2350
10	Nothing	.....	.....	445	535
11	Seaweed	10 cords..	40 00	1720	1530
12	Sulphate of Potash	160 lbs...	2 72	300	480
13	{ Bone Black ....320 Ground Bone 400	720 " ...	10 72	1525	1135
14	{ Muriate of Potash ....160 Ground Bone..........400	560 " ...	10 44	1040	1875
15	{ Stable Manure Ground Bone	6 cords... 400 lbs...	46 60	2700	1940
16	Ground Bone	400 " ...	6 60	700	560
17	{ Seaweed Ground Bone	10 cords.. 400 lbs...	46 60	2070	1720
18	{ Sulphate of Potash ...160 Ground Bone..........400	560 " ...	9 32	950	805
20	{ Muriate of Potash ....160 Bone Black ....320 Sulphate of Ammonia.160	640 " ...	13 60	1460	1060
21	{ Stable Manure Muriate of Potash 160 Sulphate of Ammonia.160	6 cords... 320 lbs...	49 44	2572	1833
22	{ Muriate of Potash . . 160 Sulphate of Ammonia.160	320 " ...	9 44	620	795
23	{ Seaweed Muriate of Potash .. 160 Sulphate of Ammonia.160	10 cords.. 320 lbs...	49 44	2045	1710
24	{ Sulphate of Potash ...160 Muriate of Potash ....160 Sulphate of Ammonia.160	480 " ...	11 16	430	560

The past season, 1890, the plots were plowed seven inches deep with the Syracuse Sulky Swivel plow on May 12th, well harrowed, as the previous year, the chemicals applied and cultivated into the surface soil and the same variety of corn, white flint, planted May 29th. The plots were cultivated June 21st, July 18th, 28th and August 7th and hoed June 30th, July 18th, August 4th and 13th. The corn was cut and shocked on September 24th, and husked October 20th and November 3d, care being exercised to prevent any variation in weight through difference in date of husking. For the various chemicals and manure applied, with cost of same and weight of crop, calculated to amount per acre, the reader is referred to the table for 1890.

FERTILIZER EXPERIMENT WITH CORN—1890.

Plot.	Fertilizer Applied per Acre. Kind.	Quantity.	Cost.	Yield of Corn per Acre. Pounds of hard ears.	Pounds of soft ears.	Total pounds of ears.	Pounds of stover.
7	Bone Black.......... . ..	180 lbs...	$ 2 34	270	370	640	1660
8	Muriate of Potash.........	110 " ...	2 64	110	90	200	650
9	Stable Manure............	6 cords...	40 00	4360	1310	5670	11910
10	Nothing.................	....	....	60	160	220	490
11	Nothing .... (Seaweed in '89).	. ...	....	890	790	1680	3530
12	Sulphate of Potash	200 lbs...	3 40	340	260	600	660
13	Bone Black ....180 Ground Bone ...400	580 " ...	8 94	1190	930	2120	4030
14	Muriate of Potash....110 Ground Bone 400	510 " ...	9 24	1156	980	2136	3690
15	Stable Manure... ..... Ground Bone	6 cords... 400 lbs...	46 60	5450	1090	6540	9960
16	Ground Bone.	400 " ...	6 60	460	610	1070	1820
17	Ground Bone..... ..... (Seaweed in '89).	400 " ...	6 60	2900	1030	3930	7130
18	Sulphate of Potash ..200 Ground Bone .. . 400	600 " ...	10 00	1120	640	1760	2570
20	Muriate of Potash...110 Nitrate of Soda 160	270 " ...	6 48	510	620	1130	1120
21	Stable Manure . .. . Muriate of Potash ...110 Nitrate of Soda......160	6 cords... 270 lbs...	46 48	4170	1310	5480	9920
22	Muriate of Potash ...110 Nitrate of Soda . ..160	270 " ...	6 48	30	120	150	610
23	Muriate of Potash ...110 Nitrate of Soda......160 (Seaweed in 89).	270 " ...	6 48	1300	760	2060	3670
24	Sulphate of Potash ..100 Muriate of Potash... 110 Nitrate of Soda......160	370 " ...	8 18	25	190	215	1370

SUMMARY.

Looking carefully through the table of yields for 1889, we find that the "nothing plot," No. 10, gave a very small yield, less than half a ton of corn and stover together, indicating a great dearth of plant food in the soil. Plot No. 12 to which sulphate of potash only was applied gave a still smaller yield, and No. 8 which received muriate of potash only, did but little better. No. 24, which received both the muriate and the sulphate of potash and nitrogen in the

form of sulphate of ammonia, gave a few pounds less corn and a little more fodder than the "nothing plot." No. 22 was fertilized the same as No. 24 less the sulphate of potash, but gave a larger crop. The yield of the plots mentioned shows that the application of potash was of little or no benefit and that the addition of nitrogen in the form of sulphate of ammonia was of little value.

Let us compare the plots to which phosphoric acid was applied in the form of bone black and fine ground bone, with the plots just considered. On plots 7, 16 and 18 the *average* yield in round numbers was 1058 pounds of corn and 818 pounds of stover, while the average cost of bone was $7.16—phosphoric acid was the principal element applied to these plots although of course the fine ground bone contained a little nitrogen. Plots 8, 12, 22 and 24 gave an *average* yield of 455 pounds of corn and 594 pounds of stover at an average cost of $6.79, therefore an additional expense of five per cent. for bone phosphates gave an increase of 132 per cent. of corn and 37 per cent. of stover in the average yield over the potash and sulphate of ammonia plots.

The bone phosphates on plot 18, at 27 per cent. of the cost of seaweed or stable manure, gave 88 per cent. as much corn and 74 per cent. as much stover as the seaweed (plot 11), and 51 per cent. as much corn and 48 per cent. as much stover as the stable manure plot (No. 9).

Stable manure (plot 9) at the same expense per acre gave better results than seaweed (plot 11), the yield of corn being 72 per cent. greater and the yield of stover 107 per cent. greater. Comparing plot 9 with plots 15 and 21 we find that the addition of chemicals to the stable manure *did not* increase the crop as the yield of plot 9 was the greatest.

Comparing plot 11 with plots 17 and 23, we find that the addition of chemicals to the seaweed *increased* the crop, and the ground bone was a more economical addition than muriate of potash and sulphate of ammonia.

Turning to the table of yields for 1890 and comparing the crop from the "nothing plot" No. 10 with the yield the previous year, as a basis, we find there was very little hard corn and that the total yield was 51 per cent. *less* than in '89 and the weight of fodder had decreased 9 per cent. Comparing the yields of grain on plots 8 and 12 with No. 10, we find that muriate of potash gave a smaller crop than the "nothing plot" and that the sulphate of potash gave 200 per cent. more than the muriate and 100 per cent. more than in '89, while the yield on the muriate was only 42 per cent. of the crop of '89. The low grade of sulphate of potash was used and the same quantity of *actual potash* was applied to the two plots.

Comparing the bone phosphate plots 7, 16 and 13 with the potash and nitrogen plots 8, 12, 22 and 24 we find an *average* cost of the phosphates of $5.96 gave an average yield of 1276 pounds of corn and 2503 *pounds of stover* as against an average expense of $5.15 for pot-ash and nitrogen, which produced an average yield of 291 pounds of corn, and 822 pounds of stover—*hence an increase* of 15 per cent. in the cost of the bone phosphates gave an increased yield of 336 per cent. of corn and 204 per cent. of stover over the crop produced by the application of potash and nitrogen. This corresponds with the results of the previous season and indicates the benefit to be expected from the application to this particular field of fertilizers containing a large per cent. of phosphoric acid.

Plots 9, 15 and 21 received as much stable manure as in '89—making $80 worth per acre in the two seasons. Plot 9, which received stable manure only gave a large increase in the crop over that of '89—5670 pounds of corn on the cob, or 78.74 bushels at 72 pounds to the bushel. The addition of ground bone on plot 15 gave this season an increase over plot 9 and the largest yield of corn of any plot—6540 pounds, of which 83 per cent. was hard corn as against 74 per cent. of hard corn on plot 9, which illustrates the

influence of phosphoric acid in the development of hard, sound corn. The yield of plot 15 was equivalent to 90.83 bushels of shelled corn per acre. Plot 21 did not give as good a crop as plot 9.

To plots 11, 17 and 23 was applied in '89, $40.00 worth of seaweed but none in '90, consequently plot 11 received nothing this year, yet the yield of corn was nearly as great as last season and that of stover more than double, while the influence of ground bone is plainly seen in the yield of plot 17 as compared with plot 23 this season and the yield of the same plots last season. The decrease in the yield of corn on plots 22 and 24 over the yield of '89 is particularly noticeable and *probably* due to the utter exhaustion of the phosphoric acid in the soil of these plots.

CONCLUSIONS.

From this experiment it is evident that the soil is very deficient in phosphoric acid and that unless that element is supplied the expenditure of money for other fertilizing elements is a positive waste.

The same money value of stable manure produces better results than seaweed.

POTATOES.

In the tenth acre plots laid out as described in fertilizer experiment with corn, plots 1-6 inclusive were planted to potatoes in '89 and '90. Twenty rows were planted across each plot and to each five rows was applied a different kind, or a greater or less quantity of chemicals than to the adjoining five rows. The plot was so divided in planting the rows that each five occupied just one-fortieth of an acre, making 24 plots. As in the corn experiment the plan was to compare seaweed and stable manure and ascertain what chemical or chemicals would give the best results. In '89 the blight (potato rot) so affected the potatoes that the results are not of value. Manure was applied broadcast during the winter to plot

3 but no seaweed to plot 5. The ground was thoroughly plowed April 25th, harrowed the last of April and the seed planted May 1st. Variety: "Houlton," Early Rose, large sized tubers cut to one and two eyes, and planted fifteen inches apart in drills 4 to 6 inches deep. Two light furrows were then thrown together over the potatoes, the fertilizer scattered along the ridge and raked into the surface soil.

June 2d, the potatoes were just breaking through the surface and the plots were thoroughly "bushed," the horse traveling between the drills. This operation tore off the earth at the top of the ridges including any small weeds which had sprung up and left the soil open when the potatoes were coming through. A "Planet Jr." cultivator was run between the drills on June 9th, 17th, 21st and July 8th and 18th and a hand hoe was used to stir the earth between the potatoes in the drill on June 17th, 25th and July 18th. What few weeds survived were pulled by hand August 13th. London purple mixed with plaster at the rate of 1 pound of purple to 100 pounds of plaster was applied June 22d and July 2d to destroy the potato bug larvae. The crop was dug September 29th and 30th.

POTATOES 1-10 ACRE PLOTS.

Plot.		Fertilizer Applied per Acre. Kind.		Quantity.	Cost.	Crop produced, bushels per acre.
1	1	Sulphate of Ammonia		400 lbs.	$14 00	9.33
	2	Muriate of Potash	200			
		Sulphate of Ammonia	200	400 "	11 80	23.33
	3	Bone Black	200			
		Sulphate of Ammonia	200	400 "	9 60	21.33
	4	Muriate of Potash	200			
		Bone Black	200			
		Sulphate of Ammonia	200	600 "	14 40	66.33

POTATOES 1-10 ACRE PLOT—CONTINUED.

Plot.		Fertilizer Applied per Acre. Kind.	Quantity.	Cost.	Crop produced, bushels per acre.
2	5	Ground Bone	400 "	6 60	138.33
	6	Ground Bone 200 Muriate of Potash 200	400 "	8 10	114.66
	7	Ground Bone 200 Sulphate of Ammonia 200	400 "	10 30	55.00
	8	Ground Bone 200 Sulphate of Ammonia 200 Muriate of Potash 200	600 "	15 10	64.00
3	9	Stable Manure	6 cords	40 00	280.00
	10	Stable Manure Muriate of Potash 200	6 cords 200 lbs.	44 80	265.00
	11	Stable Manure Muriate or Potash 200 Sulphate of Ammonia 200	6 cords 400 lbs.	51 80	211.00
	12	Stable Manure Muriate of Potash 200 Sulphate of Ammonia 200 Bone Black 200	6 cords 600 lbs.	54 40	244.66
4	13	Nothing			32.00
	14	Nitrate of Soda	200 lbs.	4 80	21.00
	15	Nitrate of Soda 200 Muriate of Potash 200	400 "	9 60	14.00
	16	Nitrate of Soda 200 Muriate of Potash 200 Bone Black 200	600 "	12 20	84.66
5	17	Nothing (Seaweed in 1889).			62.66
	18	Muriate of Potash 200 (Seaweed in 1889).	200 "	4 80	87.00
	19	Muriate of Potash 200 Sulphate of Ammonia 200 (Seaweed in 1889).	400 "	11 80	55.33
	20	Muriate of Potash 200 Bone Black 200 Sulphate of Ammonia 200 (Seaweed in 1889).	600 "	14 40	153.33
6	21	Ground Bone 400 Sulphate of Potash 400 Sulphate Lime (plaster) 400	1200 "	14 80	112.33
	22	Muriate of Potash 400 Nitrate of Soda 200 Bone Black 400	1000 "	19 60	204.33
	23	Sulphate of Potash 400 Nitrate of Soda 200 Bone Black 400	1000 "	16 80	128.33
	24	Nothing			16.66

The table for convenience may be divided into six parts of four plots each, as numbered.

Sulphate of ammonia was used on the first series, alone and in connection with potash and bone black. Used alone, the crop produced was very much less than where nothing was applied—plots 13 and 24. Potash or bone more than doubled the yield but even when all three elements were applied in plot 4, the quantity was not large enough to prove profitable.

On the second series, ground bone was used with muriate of potash and sulphate of ammonia—and an application of 400 pounds of bone at a cost of $6.60 gave far better results than half as much bone with potash or ammonia alone or together at quite an increase in cost.

On the third series, stable manure was applied in '89 at the rate of 6 cords per acre, and the same in 1890—making a cost of $80 per acre for the two years: The crop would be considered good and the potatoes were smooth and of good quality. Stable manure alone gave a greater yield than when chemicals were added.

Of the fourth series, the first plot received nothing and gave at the rate of 32 bushels per acre, mostly small ones. Nitrate of soda and potash applications gave even poorer results, but on plot 16 the use of the three essential elements of fertility gave a marked increase in the crop.

The fifth series had the benefit of an application of 10 cords of seaweed in '89 and a fair crop was produced on plot 20 by the use of muriate of potash, bone black and sulphate of ammonia.

On the sixth series the quantity of chemicals used was increased. Plot 21 had an application of sulphate of lime (plaster) with ground bone and sulphate of potash, each 400 pounds—and gave a medium crop. Plot 22 gave the best yield of any plot fertilized with chemicals, and, the cost considered, a more profitable crop than plot 9 (stable manure). Plot 23 was fertilized the same as

22 excepting that sulphate of potash was used instead of muriate. *The great difference in yield in favor of the muriate is worthy of note, but additional work is necessary to substantiate results.*

The value of phosphoric acid is as evident in the results of this experiment as in the corn experiment.

A well balanced fertilizer in sufficient quantity is more economical than stable manure at a cost of $6.66 per cord on the field. (Compare plots 22 and 9.)

OTHER EXPERIMENTS.

Some work was done in comparing shallow and deep plowing for potatoes, and shallow planting in drills as compared with the "Rural Trench System." Also in comparing various methods of treating seed potatoes to secure an early crop, and the result of planting potatoes from which the sprouts had been removed—more work in the same line will be done this season.

Thirty-two varieties of oats, 28 varieties of barley and 21 of wheat were sown on plots of 6 x 8 feet and duplicate plots will be sown for further comparison this season.

FARM CROPS.

Aside from the land devoted to experimental work, orchards, etc., but little was cultivated. About 110 bushels of carrots were grown for feeding the horses, and two and a half tons of Hungarian grass. The field from which rye was harvested has been seeded to grass and the remainder of the plain land west of the barn was plowed during the autumn.

The hay crop was estimated at twenty-four tons of upland hay and three tons of meadow hay,—all, cut early and secured in good order.

Much of the time of both men and teams has been devoted to the

improvement of the farm and grounds—removing rocks, stones and brush, draining, grading and work of like character.

DONATIONS.

The Earle Phosphate Co. presented the Station with one ton of Earle's Horsefoot Guano which has been used in part with experiments this season with good results.

In September, the Geneva, New York, Experiment Station, Dr. Peter Collier, Director, presented the Station with two registered Ayrshires. The bull is named "*Geneva Boy*" and was dropped February 5, 1890. Sire, "Tascott," No. 4335; Dam, "Miss Flow," No. 10148.

The heifer was dropped July 24th, 1890. Sire, "Dynamite," No. 4343, and dam "Queen Duchess," No. 9789. She is named "*Geneva Belle.*"

Sixteen pamphlets (on different subjects) from the Smithsonian Institution.

Report New York State Entomologist.

Reports of the Wisconsin Dairymen's Association, D. W. Curtis, Secretary.

Report State Board of Agriculture of Vermont, W. W. Cooke, Secretary.

Report of the State Board of Horticulture of the State of California, B. M. Lelong, Secretary.

Report of the Board of Agriculture of New Hampshire, N. J. Bachelder, Secretary.

Report State Board of Agriculture of Nebraska, Robt. W. Furnas, Secretary.

Report of the Board of Directors of the Kansas State Historical Society, F. G. Adams, Secretary.

A Census of the Grasses of New South Wales, H. C. L. Anderson, Director.

Eleven reports of the Inspector of Milk of Rhode Island, Edwin C. Calder, Inspector.

Full set of reports of the Board of State Charities and Corrections of Rhode Island, W. W. Chapin, Secretary.

Report of the State Board of Agriculture of Rhode Island, David S. Collins, Secretary.

Report of the State Board of Agriculture of Virginia, Thomas Whitehead, Commissioner.

Report of the Secretary of the State Horticultural Society of Michigan Edwy C. Reid, Secretary.

Report of the State Horticultural Society of Missouri, L. A. Goodman, Secretary

Report of the Department of Agriculture for the Province of Ontario, Charles Drury, Minister of Agriculture.

Report of the Kansas State Board of Agriculture, M. Mohler, Secretary.

Agricultural Gazette, New South Wales, H. C. L. Anderson, Director.

Several Reports of the United States Department of Agriculture, etc.

Report Ohio State Forestry Bureau.

The future of Agriculture in the United States, by Dr. Peter Collier, Geneva, N. Y.

Synopsis of experiments made by J. W. Sanborn at the Missouri Experiment Station.

Report of the Annual Session of the Virginia State Grange, Thomas S. Stadden, Secretary.

Report of the Commissioner of Agriculture of the State of Louisiana, T. J. Bird, Commissioner.

Report upon Tuberculosis, and its prevalence among the neat cattle of Rhode Island. Charles H. Fisher, Secretary State Board of Health.

Report of the National Farmers' Congress of the United States.

Annual Reports and Bulletins of all the experiment Stations, and newspaper exchanges as follows:

Rural New Yorker, New York.

Baltimore Weekly Sun, Baltimore, Md.

Mirror and Farmer, Manchester, N. H.

Industrial News, Toledo, Ohio.

Southern Cultivator and Dixie Farmer, Atlanta, Ga.

Pomona Herald, Providence, R. I.

The Practical Farmer, Philadelphia, Pa.

The Agricultural Epitomist, Indianapolis, Indiana.

Sentinel and Advertiser, Hope Valley, R. I.

The Holstein Friesian Register, Boston, Mass.

The Monthly Bulletin, Tallahassee, Florida.

Western Resources, Lincoln, Neb.

Western Garden and Poultry Journal, Des Moines, Iowa.

The Western Farmer and Stockman, Sioux City, Iowa.

The Farmer's Home, Dayton, Ohio.

Horticultural Art Journal, Rochester, N. Y.

The New Dairy, New York, N. Y.

Review and Farmer, Pueblo, Colorado.

CHEMICAL DIVISION.

H. J. WHEELER.

The work of completing the Chemical Laboratory which it was hoped would be accomplished early in the year (1890), was seriously delayed from various causes and it was not until the early spring that the cases of chemical apparatus, which had been stored since their arrival from Germany, could be transferred to the Chemical Laboratory, and since the building was not yet fully completed the material was unpacked and temporarily placed where it would not interfere with the further work of painting and finishing. Upon the completion of the Laboratory a temporary water supply was obtained by use of a hydraulic ram which was placed in the run north of the building. Owing to the dry weather which now ensued this supply failed before the necessary working apparatus could be washed and suitably arranged. The contract for the Laboratory building did not include fume-chambers and many of the necessary shelves and cases. To meet this necessity, arrangements were made for their construction, which was begun at once. It was already late in the autumn before these additions were completed.

For some time previous to the introduction of the temporary water supply referred to above, the Board of Managers had been considering the matter of a permanent supply adapted to all the needs of the institution, in the form of an artesian well sur-

mounted by a large water tank and wind motor. The contract for the same was finally awarded and at the close of the summer operations began. The contract for connecting the buildings with this supply was also soon awarded and the whole had so far progressed that by the use of a hand pump, water was forced into the water tank so that in October, the work of washing and arranging apparatus, of mixing and preparing solutions for analytical work, etc., began. From that time to the present, except for the serious interruption consequent upon the calculation, compilation and arranging for publication of the results of the series of co-operative field experiments (the details of which will be found in another place in this report), the work of analysis and further equipment of the Laboratory has been in progress. The charge of these co-operative experiments was put into my hands in March, by Director Flagg, whose many other duties interfered with the conduct of the same. Letters explaining the proposed plan were sent to Masters of Granges and other representative farmers in the State; as a result of which, after further correspondence, twenty-one definite applications were received, and ten fields of an acre each, not including one upon the Station farm, were selected for the trials. My personal attention was given in the factory to the weighing out of the fertilizers required for this purpose and as a further preparation for the experiment, a visit was made to each of the ten experiment fields in the various sections of the State, and with a transit each field was accurately surveyed and laid off into twenty plots, each comprising one-twentieth of an acre. For the purpose of special observation on the experiments most of the plots were again visited just before harvesting.

During the early portion of the year, I was called upon as heretofore to assist the Director in the general business, correspondence, etc., connected with the welfare of the institution, and later, in connection with the field experiments and in surveying and locating buildings, roads and walks.

After making a careful study of the relative merits of all the different gas machines on the market, a Springfield gas machine with "mixing regulator" was purchased and set in position. The gas furnished is fully equal to city gas, for all laboratory and illuminating purposes, and is produced at less cost. Special attention has been devoted to the details of piping the Laboratory work benches for gas, with the attempt to combine the greatest convenience and economy. It gives me much pleasure to be able to report that the work of this Division is now in progress.

All fodders and fertilizing materials of every nature, will, in case the results are of more or less general interest, be examined free of cost to parties sending the same, the Station reserving in such case, the right to publish the results.

GENERAL ANALYSES OF FERTILIZING MATERIALS, WASTE PRODUCTS AND WATER.

1. Muriate of Potash.

Used in 1890 in the Station experiments.

Water	2.13	per cent.
Potash (potassium oxide)	50.82	" "

2. Dissolved Bone Black.

Used in 1890 in the Station experiments.

Water	8.04	per cent.
Total phosphoric acid	21.21	" "
Soluble " "	14.17	" "
Reverted " "	3.85	" "
Insoluble " "	3.19	" "

This material is made from the refuse bone black of the sugar refineries by treatment with sulphuric acid, by which a large proportion of the phosphoric acid is rendered soluble.

3. Dissolved Bone.

Sent for analysis by J. F. Reynolds, Olneyville, R. I.

Water	6.31	per cent.
Total phosphoric acid	20.63	" "
Soluble " "	1.34	" "
Reverted " "	8.08	" "
Insoluble " "	11.21	" "
Nitrogen	3.15	" "

Commercial valuation per ton upon the basis for 1889, $40.35. The low "soluble" and the high "reverted" acid is explained by the fact that a long interval had elapsed since its manufacture, on which account much of the soluble acid had passed into the reverted form.

4. Ground Bone.

Sent for analysis by D. S. Knowles, Point Judith, R. I.

Water	8.61	per cent.
Total phosphoric acid	23.27	" "
Nitrogen	4.09	" "

This sample of bone was exceptionally coarse which consequently lowers its real value as a fertilizer. In purchasing commercial fertilizers, bone, etc., the chemical composition should not only be taken into consideration, but also the fineness of the same.

5. Well Water.

Sample drawn during July, 1890, from the old well on the Station farm.

	Parts per Million.
Actual ammonia	0.00
Albuminoid ammonia	0.10
Chlorine	10.00

The question of water analysis and the value of the same in determining the healthfulness of drinking waters will be discussed in a future issue of the. Station.

Wood Ashes.

6. Sent for analysis by O. P. Howard, Tiverton, R. I.

9. Canada hard wood ashes sent to the Experiment Station as a sample by the general agents, Munroe Judson & Stroup, Oswego, N. Y.

10. Sent for analysis by J. Herbert Shedd, from West Kingston, R. I.

	6	9	10
	Per cent.	Per cent.	Per cent.
Water	3.72	7.32	10.63
Potash, (K_2 0)	3.43	4.58	5.53
Phosphoric acid	2.95	1.54	1.92
Lime, (Calcium oxide)	22.17	32.28	33.08
Magnesia, (Magnesium oxide)		2.91	4.37

From these analyses it will be seen that wood ashes vary widely in their composition, and the necessity for their purchase only upon a guaranteed analysis is consequently apparent.

7. Cotton Waste.

From the Union Wadding Works, Pawtucket, R. I.

This material is sold to farmers who use it as bedding for their stock. Four samples were taken. Sample A. had been colored but was fairly clean. Sample B. was uncolored and was also clean. Sample C. was less pure and contained considerable coarse matter. Sample D. contained still more coarse, foreign matter than the preceding one.

Tests were made to determine their relative power of absorption, with the following results:

Sample	A.	100	pounds	absorbed	453	pounds	of water
"	B.	"	"	"	550	"	"
"	C.	"	"	"	231	"	"
"	D.	"	"	"	267	"	"

A chemical analysis of Sample C. was made, which represented about the average of all the samples. The following is the result:

Water	5.48 per cent.
Nitrogen	1.55 " "
Phosphoric acid	0.48 " "
Potash, (K_2 0)	1.05 " "
Lime, (Calcium oxide)	1.49 " "
Magnesia, (Magnesium oxide)	0.42 " "
Insoluble matter, sand, etc	35.72 " "

This material is especially valuable as an absorbent in retaining the liquid or more valuable portion of the manure. Its real value as a fertilizer can only be determined by actual experiment.

8. Wool Waste.

Sent for analysis by J. Herbert Shedd, City Engineer, Providence R. I.

Water	1.89 per cent.
Nitrogen	2.79 " "
Phosphoric acid	0.17 " "
Potash, (K_2 0)	0.35 " "
Lime, (Calcium oxide)	0.19 " "
Magnesia, (Magnesium oxide)	0.08 " "
Insoluble matter, sand, etc	49.33 " "

Estimating nitrogen at 15 cts., potash at 4½ cts. and phosphoric acid at 5 cts. per pound, this material would have a commercial

value of $8.86. Its value as a fertilizer depends upon the rapidity with which it becomes available to the plant and this can only be determined by actual experiment. The following from a letter from Mr. Shedd gives an idea of how this material is obtained:

"In reply to your favor of the 22d inst. I have to say that the material sent to you was residue from the treatment of wool wastes to secure "de gras." The washings from the machines where the wool is scoured, carrying about 50 per cent. of wool waste, are run through pipes to settling basins in the ground. From the time the washings leave the machines until the residue is turned out of the canvas bags, about a week elapses. The water stands in the settling basins in the ground, say two days. Such water as would soak off at that time escapes, the rest is pumped into tanks, say eight or ten feet cube, where six or seven gallons of acid (oil of vitriol) is supplied to each tank. After remaining in the tanks about fourteen hours, during which time the heavier portion settles to the bottom and the lighter portion rises to the top, the intermediate water is siphoned off and the heavier and lighter portions together are run on to filter beds where it remains to drain away the water for about two days. Then, when dry enough, it is shoveled into sheets of canvas folded over so as to make a package about one foot by two feet and laid in a press between metal plates, where it is subjected to steam for about fourteen hours and during which time it is put under pressure and the oil squeezed out, filtering through bags. The oil is refined by steam. The residue remaining in the bags is then spread upon a floor of steam pipes, where it is dried, and it is afterwards ground in a mill, coming out in the form sent to you for examination."

11, 12 and 13. Sewage Samples.

Sent for analysis by J. Herbert Shedd, City Engineer, Providence, R. I.

	No. of lbs. in 1000 lbs. of sewage.		
	11.	12.	13.
Dry matter at 100° C........	1.834	1.123	4.772
Nitrogen	0.328	0.198	1.188
Phosphoric acid.............	0.039	0.063	0.093
Potash, (K_2 0).............	0.044	0.007	0.186
Lime, (Calcium oxide)......	0.052	0.025	0.083
Magnesia, (Magnesium oxide)	0 014	0.013	0.013
Insoluble matter, sand, etc...	0.016	0.153	0.117

No. 11. Was from "Mason's packing-house drain east of R. R. track and just north of slaughter-house drain. Sample taken November 13th, 1890, at 3.35 P. M."

No. 12. Was from "Mason's slaughter-house drain east of R. R. track. Sample taken November 13th, 1890, at 3.30 P. M."

No. 13. Was from "Comstock's slaughter-house drain east of R. R. track and north of Mason's. Taken November 13th, 1890, at 3.50 P. M."

Samples 11 and 12 contained large amounts of chlorine, probably in the form of common salt.

14. Examination of a so-called "Dyestuff."

The attention of the Director was called to the fact that a party was selling a so-called "dyestuff" throughout the northern portion of the State, which appeared to be a fraudulent article. The material sold for each color, excepting black, had a brown appearance resembling that of linseed meal, and on a trip through the section of the State where it had been sold several samples of these were obtained. The black "dye" was said to resemble fine coal dust but we were unable to obtain a sample. The samples collected were subjected to a microscopical examination, which to-

gether with a qualitative chemical analysis of the ash which remained after burning, established its further resemblance to linseed meal.

By quantitative determinations 7.06 per cent. of fat and 5.55 per cent. of nitrogen were found, corresponding with the percentages for linseed meal. Naturally all attempts to dye with it were fruitless.

A circular letter was at once sent to each newspaper in the State calling the attention of the public to the fraud.

CO-OPERATIVE FIELD EXPERIMENTS WITH FERTILIZERS, ON INDIAN CORN.

H. J. WHEELER.

During the winter of '89 and '90, at the suggestion of Prof. Flagg who proposed to take charge of the matter, it was decided that the Station should undertake a system of co-operative field experiments with fertilizers, provided enough farmers in the different sections of the State were ready to co-operate in the work.

As the season advanced the demands made upon the time of the Director, in connection with the erection of the dormitory and boarding-house and the other routine business of the Station, rendered it necessary that some one should relieve him of the work and at his request I assumed charge of the experiments.

In accordance with the above mentioned plan and for the purpose of reaching parties who might be interested, the following circular letter was sent to the master of each grange in the State and also one of like import to individual farmers in other localities :

STATE AGRICULTURAL EXPERIMENT STATION,

KINGSTON, R. I., March 26th, 1890.

DEAR SIR:

In several States a uniform system of co-operative field experiments has been adopted for the purpose of learning in what elements, if any, our soils are deficient and to serve as an aid in familiarizing the farmers with methods of experimenting. The Station at Kingston desires to pursue a similar course provided there are farmers in the different sections of the State who are ready to co-operate in the work.

It is desired to know, as soon as possible, if anyone in your grange would like to undertake such an experiment. All fertilizers and seed will be furnished free of charge to parties undertaking the same, and the Station will advise as well as aid directly in their execution. One acre of moderately level land would be required, and should it seem advisable, the experiment may be continued upon the same land for several seasons.

The Station asks no returns in the form of crops or money, expecting only that the work will be conducted in a careful, conscientious manner, so that the results, which the Station reserves the right to publish, may be of value to other farmers.

The crop selected for this season will probably be Indian corn.

Will you kindly embrace the earliest opportunity for bringing the matter before the members of your grange?

We send by same mail copies of printed bulletins giving the necessary detailed information. Communications relating to the work should be addressed to,

Yours sincerely,

CHARLES O. FLAGG, *Director*.

In response several letters were received asking for more detailed information, to which replies were immediately sent, followed by another circular letter stating that applications to receive consideration should be sent in by May 1st. On that date twenty-one applications were on file.

Considering the amount of labor and time involved in weighing out and putting up the fertilizers at the factory and in visiting the various farms for the purpose of accurately laying out the experimental plots, it was decided to undertake but eleven experiments including one on the Station farm. In general a choice was made

of such fields as would best represent the different soils of the State and in case of several applications from one locality the selection was made by lot. The following are the names and addresses of the parties whose fields were thus selected:

E. F. Crowninshield, Abbott Run, R. I.
H. Hartwell Jencks, Lime Rock, R. I.
Capwell & Tillinghast, Summit, R. I.
J. B. Vaughan, Nooseneck, R. I.
A. A. Sherman, Davisville, R. I.
Elmer K. Watson, Nayatt Point, R. I.
Thomas A. H. Tefft, Jamestown (north end), R. I.
David T. Briggs, Jamestown (south end), R. I.
Herbert E. Lewis, Hope Valley, R. I.
Courtland P. Chapman, Westerly, R. I.

The area under experiment in every case consisted of twenty plots, each containing one-twentieth of an acre.

The following diagram shows the arrangement of the plots and the kind and amount of fertilizers applied.

PLAN OF EXPERIMENTAL FIELDS

Showing the arrangement of plots and the kind and amount of fertilizers applied. Twenty plots, each plot one-twentieth of an acre. Where possible unmanured strips were left between the plots.

0.	No Manure.
1.	Nitrate of Soda, 7.5 lbs.
2.	Dissolved Bone Black, 17.5 lbs.
3.	Muriate of Potash 7.5 lbs.
4.	Nitrate of Soda, 7.5 lbs.; Dissolved Bone Black, 17.5 lbs.
5.	Nitrate of Soda, 7.5 lbs.; Muriate of Potash, 7.5 lbs.
6.	Dissolved Bone Black, 17.5 lbs.; Muriate of Potash, 7.5 lbs.; "Mixed Minerals."
7.	Mixed Minerals as No. 6, plus Nitrate of Soda, 7.5 lbs., ⅓ Ration.
8.	Mixed Minerals as No. 6, plus Nitrate of Soda, 15 lbs., ⅔ Ration.
9.	Mixed Minerals as No. 6, plus Nitrate of Soda, 22.5 lbs., full Ration.
6*a*.	Mixed Minerals. Duplicate of No. 6.
10.	Mixed Minerals as No. 6, plus Sulphate of Ammonia, 5.6 lbs., ⅓ Ration.
11.	Mixed Minerals as No. 6, plus Sulphate of Ammonia, 11.2 lbs., ⅔ Ration.
12.	Mixed Minerals as No. 6, plus Sulphate of Ammonia, 16.8 lbs., full Ration.
6*b*.	Mixed Minerals. Duplicate of No. 6.
13.	Mixed Minerals as No. 6, plus Dried Blood, 11 lbs., ⅓ Ration.
14.	Mixed Minerals as No. 6, plus Dried Blood, 22 lbs., ⅔ Ration.
15.	Mixed Minerals as No. 6, plus Dried Blood, 33 lbs., full Ration.
6*c*.	Mixed Minerals. Duplicate of No. 6.
00.	No Manure.

Where possible unmanured strips were left between the plots. The fields being of different forms the plots on no two fields were of exactly the same length and breadth. In general, the hills were three feet apart in the row and the rows from three to three and a half feet apart according to the width of the plot.

After harrowing, the fertilizer was sown broadcast upon each plot and harrowed in. Care was taken in sowing that the fertilizers should be kept back a little from the edges of the plots and that in harrowing it should not be dragged over upon the unmanured strips or the adjoining plots. The crop selected was Indian corn and the seed, which was furnished by the Station, was alike in every instance. So far as possible the corn was thinned out to four stalks to the hill.

The plan of the experiment was not to get the greatest possible yield, nor to see who could grow the most corn with the same amount of fertilizers, nor was it to test methods of cultivation and tillage.

OBJECTS OF THE EXPERIMENT.

The experiments were planned for three purposes: 1. That of learning, if posssible, in what elements some of the soils of the State are especially lacking. 2. For testing the relative fertilizing value of nitrogen in the various nitrogenous compounds, such as nitrate of soda, sulphate of ammonia and dried blood. 3. To learn something, if possible, of the probable profit or loss from large and small applications of nitrogen to the Indian corn crop.

In reply to the question which might be raised at this point: "Why cannot the needs of a soil be determined by a chemical analysis? we quote the following from Bulletin No. 8 of this Station: "It is in general understood that those elements in the soil which are soluble in water are directly available as food for plants, and hence one might suppose that if a given amount of

the soil were treated with water and an analysis made of the watery solution, that this would show exactly how much available plant food is present in the soil. The facts of the case are, however, that the roots of plants are able to take even more plant food from the soil than that which water alone can dissolve. The ends of the little rootlets have been shown to be acid, and where plants are growing upon a limestone soil it is a very easy matter to find some stone over the surface of which the growing rootlet of some plant has furrowed its channel. Thus then the plant roots are acid at their extremities and their power to extract plant food from the soil is greater than that of water. If now some acid could be selected which would act in the same way and with the same strength as the plant roots, then we should be in condition to determine absolutely the amount of food which the plant can get. This chemists have vainly attempted to do, but there is little probability that it ever can be done.

If an analysis is made of the solution obtained by treating the soil with a strong mineral acid, one may learn whether some elements are totally lacking or not and in what relative quantities they are present.

The facts of the case are that practically all agricultural soils contain more or less of all the elements of plant food, yet such analyses may be very misleading, from the fact that in a given case such an analysis would show the presence of large amounts of phosphoric acid, while in reality this same phosphoric acid might be in such an insoluble form that practically none of it would be available to the plant. As further complicating the whole question of soil analysis must be mentioned the fact that not only do plant roots have an acid reaction, but from the recent investigations made by Prof. Paul Wagner, at Darmstadt, Germany, it appears that even among plants of the same general character, the feeding or dissolving power of the roots is a varying one. In the case of

wheat, barley, oats and rye, it was found that the 'feeding power' as we choose to term it, showed wide variations, and that the oat stood out in marked contrast to the rest as having exceptional power to extract potash from the more insoluble potash compounds in the soil. From this it will be seen that if the chemist could find some acid which would act in the same way and with the same strength as a given plant, we should then have no assurance that this would be any real measure of the amount of plant food which some other plant could extract from the same soil. If, then, a soil analysis is often of little or no value, the practical question presents itself: How can the needs of a soil be determined? This is a problem which several of the agricultural experiment stations have been trying to solve by letting plants answer the question for themselves. For this purpose several plots of land are laid out; one is fertilized with potash alone, one with phosphoric acid alone and one with nitrogen alone; then follow combinations of potash and nitrogen, potash and phosphoric acid and phosphoric acid and nitrogen. As a check upon the whole, other plots are left unfertilized and some are furnished with a combination of all these elements." If the soil contains all the elements but potash, in available form, it is only necessary that potash be supplied in order that plants may develop. If both potash and nitrogen are lacking the plant will develop as soon as they are furnished. From such experiments general conclusions may be drawn as to what element or elements are especially lacking.

For the purpose of throwing more light upon the relative fertilizing value of nitrogen in its various combinations, a series of plots, Nos. 6 to 6c. inclusive, as shown by the plan on page 42, were supplied with a like amount of potash and phosphoric acid. These plots were now divided into three groups of three plots each, to the first group of which (plots 7, 8 and 9) nitrogen in the form of nitrate of soda was applied. The second group (plots 10, 11 and

12) was supplied with nitrogen in the form of sulphate of ammonia, and to the third group (plots 13, 14 and 15) nitrogen was applied in the form of dried blood.

Plots 7, 10 and 13, the first plots in each of the respective groups, were given only a "$\frac{1}{3}$ ration" of nitrogen, the second plot in each group a "$\frac{2}{3}$ ration," or twice as much as the first, and the last plot a "full ration," or three times as much as the first.

From these experiments it was hoped, as stated, that some conclusions could be drawn as to the relative fertilizing value of nitrogen in these various forms and as to the probable profit or loss of large and small applications of nitrogen to the Indian corn crop.

The plan of the experiment is that adopted by the Storrs School Agricultural Experiment Station in Connecticut, the results of which in that State, are to be found in the annual reports of that station for the years 1888 and 1889.

In order to obtain the most reliable results from field experiments the land should be plotted and cropped for a few years without manure in order that the relative natural yield of the plots may first be determined. Land is being prepared in this way for experimental work at the Experiment Station, but it involves too great an outlay of time and money to be within the means of the average farmer. It not infrequently happens that plots which, so far as the eye can detect, are apparently uniform, will show wide variations in fertility from the fact that certain ones may have served as the resting place of some hay-stack, manure pile or of the ashes from some bon-fire, or owing to a slight depression have become the depository of the washings from adjoining areas. From these and other causes many plots have become so contaminated that they must be wholly excluded from the experimental field. In such experiments it has been a general custom to introduce one unmanured plot between each two manured ones, but this requires so great an outlay for tillage with but small financial

returns, that farmers are not ready to adopt such a system. By applying to intervening plots a like amount of fertilizer as was done in these experiments on plots 6, 6a and 6c in the special nitrogen test, this objection is overcome.

However much food is placed before an animal it can eat only a given amount, and so with plants, if the soil is saturated with all kinds of available plant food no application of fertilizers however great will prove remunerative or be productive of *direct* beneficial results. Suppose that the soil is full of available potash and phosphoric acid, then the application of either or both of these constituents in whatever quantities will prove profitless, but if nitrogen is lacking in such a soil, the returns from its application (up to certain limits) will be proportional to the amounts applied.

Due either to the nature of the materials from which they were formed or to the previous system of cropping, many New England soils are suffering from one-sided exhaustion. Practically it would be better economy in such a case to apply only such elements as are really lacking than to continue to furnish considerable quantities of all, for as above mentioned no financial returns can be expected from an application of such as already stand at the disposition of the plant in sufficient quantities and in a readily available form.

The following table gives the data in relation to the weight and cost of the fertilzers applied and the numbers of the plots correspond to those given in the diagram on page 42.

TABLE SHOWING WEIGHT AND COST OF FERTILIZERS.

No. of Plot.	Weight per Plot.	Kind of Fertilizer.	Weight per Acre.	Nitrogen per Acre.	Actual Potash per Acre.	Total Phosphoric Acid per Acre.	Cost delivered on board cars at Pawtucket, per Acre.
	lbs.		lbs.	lbs.	lbs.	lbs.	
0.	0.0	Nothing..........................	......	..	...	..	....
1.	7.5	Nitrate of Soda.	150	25.0	...	....	$3 60
2.	17.5	Dissolved Bone Black (14 per cent. soluble acid)	350	..	..	74.2	4 55
3.	7.5	Muriate of Potash...............	150	...	76.2	...	3 60
4.	7.5 17.5	{ Nitrate of Soda ....150 Dissolved Bone Black........350 }	500	25.0	...	74.2	8 15
5.	7.5 7.5	{ Nitrate of Soda ....150 Muriate of Potash....... ...150 }	300	25.0	76.2	....	7 20
6.	17.5 7.5	{ Dissolved Bone Black....... 350 Muriate of Potash.......... 150 } Mixed Minerals,	500	....	76.2	74.2	8 15
		NITRATE OF SODA GROUP.					
7.	25.0 7.5	{ Mixed Minerals as No. 6. ....500 Nitrate of Soda, $\frac{1}{3}$ Ration.....150 }	650	25.0	76.2	74.2	11 75
8.	25.0 15.0	{ Mixed Minerals as No. 6. ....500 Nitrate of Soda, $\frac{2}{3}$ Ration.....300 }	800	50.0	76.2	74.2	15 35
9.	25.0 22.5	{ Mixed Minerals as No. 6... ..500 Nitrate of Soda, full Ration...450 }	950	75.0	76.2	74.2	18 95
6a.	25.0	Mixed Minerals as No. 6.........500	500	....	76.2	74.2	8 15
		SULPHATE OF AMMONIA GROUP.					
10.	25.0 5.6	{ Mixed Minerals as No. 6. ...500 Sulph. of Ammonia, $\frac{1}{3}$ Ration.112 }	612	23.5	76.2	74.2	12 07
11.	25.0 11.2	{ Mixed Minerals as No. 6. .. 500 Sulph. of Ammonia, $\frac{2}{3}$ Ration.224 }	724	47.0	76.2	74.2	15 99
12.	25.0 16.8	{ Mixed Minerals as No. 6 ... .500 Sulphate of Ammonia, full Ration ....336 }	836	70.5	76.2	74.2	19 91
6b.	25.0	Mixed Minerals as No. 6.........500	500	....	76.2	74.2	8 15
		DRIED BLOOD GROUP.					
13.	25.0 11.0	{ Mixed Minerals as No. 6.... .500 Dried Blood, $\frac{1}{3}$ Ration....... 220 }	720	25.0	76.2	74.2	12 0[illegible]
14.	25 0 22.0	{ Mixed Minerals as No. 6.... .500 Dried Blood, $\frac{2}{3}$ Ration...... .440 }	940	50.0	76.2	74.2	15 8[illegible]
15.	25.0 33.0	{ Mixed Minerals as No. 6. ....500 Dried Blood, full Ration.....660 }	1160	75.0	76.2	74.2	19 7[illegible]
6c.	25.0	Mixed Minerals....... 500	500	....	76.2	74.2	8 1[illegible]
00.	0.0	Nothing..................	....	....	....	...	....

DETAILS OF THE INDIVIDUAL EXPERIMENTS.

KINGSTON, R. I.

1. The Experiment Station Experiment.

The land selected for this experiment was located on the plain on the westerly portion of the farm. The area had been in grass for many years and had become partially overgrown with moss, producing hardly enough grass to pay for the cutting. The soil to a depth of from four and a half to five inches consisted of a sandy loam underlaid by yellow loam and subsoil of alternating layers of coarse sand and gravel.

By the time the corn had reached the height of fifteen inches it was already noticeable that the value of the experiment would be materially lessened from the fact that the soil upon a considerable area, extending along the line of a slight depression running diagonally across nearly three-fourths of the plots, was far better than that upon the remaining portions of the field, and that the natural yield of the different plots would therefore not be uniform. At this time the better color of the nitrate of soda plots began to be noticeable and the same continued until the end of the season. The sulphate of ammonia plots, instead of improving with the advance of the season, began to take on a sickly yellow appearance, which gradually grew worse until just before the close of the season, when a slight improvement was here and there noticeable. The greater the application of sulphate the worse the plots appeared, which is plainly to be seen in the table giving the several yields.

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

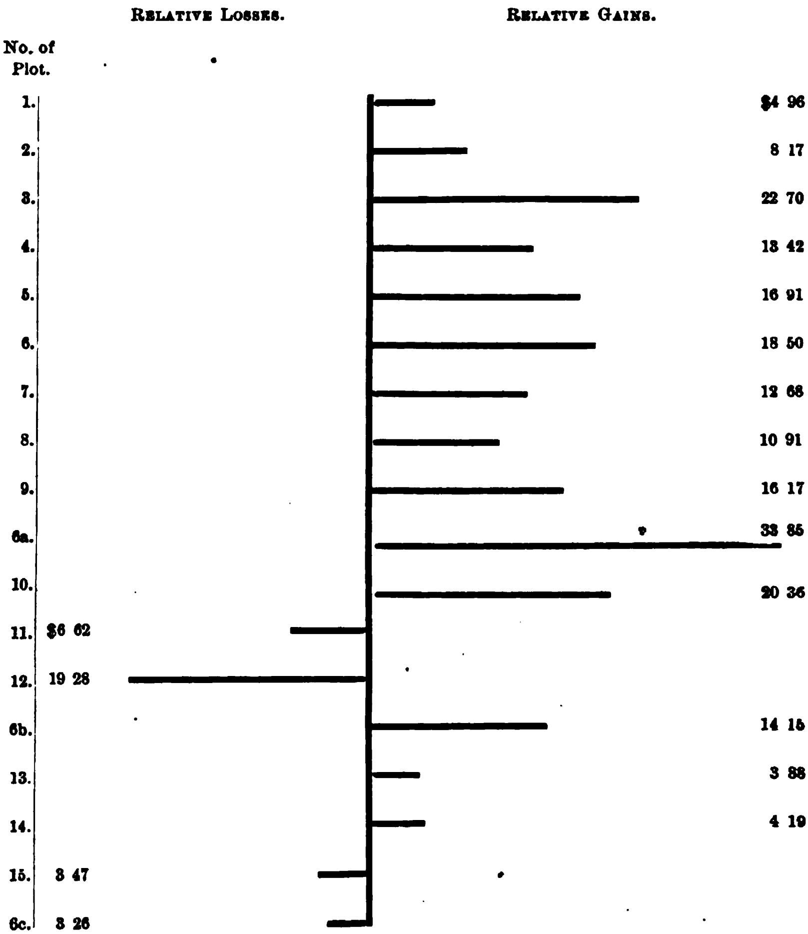
No. of Plot.	KIND OF FERTILIZER.	Total yield per Plot.			Total yield per Acre.		
		Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing........................	85.0	10.00	70.0	24.29	2.86	1400
1.	Nitrate of Soda	85.0	12.50	82.5	24.28	3.58	1650
2.	Dissolved Bone Black (14 per cent. soluble acid)...................	100.0	10.00	100.0	28.57	2.86	2000
3.	Muriate of Potash........................	155.0	3.75	135.0	44.28	1.08	2700
4.	Nitrate of Soda, Dissolved Bone Black, }	130.0	11.25	132.5	37.14	3.22	2650
5.	Nitrate of Soda, Muriate of Potash, }	145.0	5.00	132.5	41.42	1.43	2650
6.	Dissolved Bone Black, Muriate of Potash, } Mixed Minerals,	157.5	3.75	132.5	45.00	1.08	2650
	NITRATE OF SODA GROUP.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration, }	147.5	6.25	127.5	42.14	1.79	2550
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration, }	157.5	5.00	125.0	45.00	1.43	2500
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration, }	182.5	5.00	175.0	52.14	1.43	3500
6a.	Mixed Minerals as No. 6...........	215.0	7.50	170.0	61.42	2.15	3400
	SULPHATE OF AMMONIA GROUP.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration, } ..	177.5	6.25	150.0	50.71	1.79	3000
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration, } ..	92.5	10.00	75.0	26.42	2.86	1500
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration, }	55.0	10.00	65.0	15.71	2.86	1300
6b.	Mixed Minerals as No. 6	137.5	11.25	120.0	39.28	3.22	2400
	DRIED BLOOD GROUP.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration, }	120.0	7.50	87.5	34.28	2.15	1750
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration, }	135.0	5.00	105.0	38.57	1.43	2100
15.	Mixed Minerals as No. 6, Dried Blood, full Ration, }	120.0	12.50	85.0	34.28	3.58	1700
6c.	Mixed Minerals as No. 6	70.0	10 00	80.0	20.00	2.86	1600
00.	Nothing............	25.0	11.25	40.0	7.14	3.21	800

TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Stover.	Stover.	Total value per acre of corn and stover over that of the "nothing" plots.	Cost of Fertilizers per Acre.	Value of the Crop per Acre over the cost of the Fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 87½c. per bush.	lbs.	Value at $7 per ton.			
1.	8.57	$6 43	0.54	$0.20	550	$1 93	$8 56	$3 60	$4 96
2.	12.86	9 64	—0.18	—0.07	900	3 15	12 72	4 55	8 17
3.	28.57	21 44	—1.96	—0.74	1600	5 60	26 30	3 60	22 70
4.	21.43	16 07	0.18	0.07	1550	5 43	21 57	8 15	13 42
5.	25.71	19 28	—1.61	—0.60	1550	5 43	24 11	7 20	16 91
6.	29.29	21 96	—1.96	—0.74	1550	5 43	26 65	8 15	18 50
7.	26.43	19 82	—1.25	—0.47	1450	5 08	24 43	11 75	12 68
8.	29.29	21 96	—1.61	—0.60	1400	4 90	26 26	15 35	10 91
9.	36.43	27 32	—1.61	—0.60	2400	8 40	35 12	18 95	16 17
6a.	45.71	34 28	—0.89	—0.33	2300	8 05	42 00	8 15	33 85
10.	35.00	26 25	—1.25	—0.47	1900	6 65	32 43	12 07	20 36
11.	10.71	8 04	—0.18	—0.07	400	1 40	9 37	15 99	—6 62
12.	Same as average	Same as average	—0.18	—0.07	200	0 70	0 63	19 91	—19 28
6b.	23.57	17 68	0.18	0.07	1300	4 55	22 30	8 15	14 15
13.	18.57	13 93	—0.89	—0.33	650	2 28	15 88	12 00	3 88
14.	22.86	17 14	—1.61	—0.60	1000	3 50	20 04	15 85	4 19
15.	18.57	13 93	0.54	0.20	600	2 10	16 23	19 70	—3 47
6c.	4.29	3 21	—0.18	—0.07	500	1 75	4 89	8 15	—3 26

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



The most interesting fact in connection with this experiment is, that of the peculiar injurious action of the sulphate of ammonia. This was the only case in the eleven experiments in which the sulphate had a positively injurious effect, and in two or three other instances the sulphate group made a better showing than either the dried blood or the nitrate of soda.

From a glance at the table on page 51, it will be seen that the total value of the crop over that of the average of the "Nothing" plots amounted, in the case of the $\frac{1}{3}$ ration of sulphate of ammonia, to $32.43; with an additional amount of sulphate or a $\frac{2}{3}$ ration, the value was $9.37, and with a full ration of sulphate the value dropped to $0.63. The value of the crop in the instance of the $\frac{1}{3}$ ration exceeded the cost of the fertilizer by $20.36, in the case of the $\frac{2}{3}$ ration there was a loss of $6.62, and with the full ration a loss at the rate of $19.28 per acre.

We may consider two possible causes of the peculiar action of the sulphate in this experiment: 1. Our commercial sulphate of ammonia, used for agricultural purposes, is derived from coal as a by-product in the manufacture of illuminating gas. The so-called "ammoniacal liquors" from which it is made contain, among other impurities, sulphocyanides, which are poisonous to plants, and the injurious effect of the sulphate has sometimes been attributed to the presence of these compounds, which may not have been entirely removed in the process of manufacture. In this case no chemical test was made to establish the presence or absence of such compounds, but the fact that no injurious effects were noticeable in the other experiments, with the same sulphate, goes to show that we must seek for some other explanation of the facts observed.

From the experiments made by Schlössing and Müntz and others, it appears that the formation of nitrates in the decomposition of organic matter is caused by the action of the so-called

"nitric" ferment, one of the micro-organisms classed under the general name of "Bacteria." It is generally believed at the present time that nitrogen, whether in the form of organic matter, such as plants, blood, meat, etc., or in the form of sulphate of ammonia, must first be transformed into nitric acid before it can be taken up by the plant. From numerous experiments it has been found that this change is favored by exclusion of the light, the presence of a certain amount of moisture, the oxygen of the air, the presence of carbonate of lime or some other base, and also by a proper temperature. "Below 40° F. and above 131° F. this transformation practically ceases and its maximum is reached at the temperature of 98° to 99° F."

From the experiments of Warrington and others, as well as from earlier observations made in connection with the manufacture of "nitre" (saltpetre or nitrate of potash) it appears that the formation of nitrates is most active in the upper layers of the soil, i. e., to a depth not exceeding six to eight inches. The ferment was seldom found at a depth of three feet and below that depth nitrification does not apparently take place.

In the above experiment the most probable explanation of the facts observed, is found in the supposition that for some reason nitrification did not take place, or if at all, not until too late to be of any practical benefit. The fact that a slight improvement in the corn was noticeable towards the close of the season would indicate such a possibility. That the result in this instance was not due solely to the fact that the plants were not able to get their proper supply of nitrogen and were thus suffering from nitrogen hunger, is shown by the fact that plots 6, 6a, 6b and 6c, which received exactly the same amount of phosphoric acid and potash and to which no nitrogen had been given, were not thus seriously affected, but on the contrary produced a very good crop. It would appear, then, that the presence of the untransformed sulphate in

the soil acted injuriously upon the plants, and further supporting this conclusion it will be noticed that, the greater the amount of sulphate of ammonia applied, the more serious were the results.

The action of the nitric ferment practically ceases in time of *severe drouth* but the above result could not have been due to this cause from the fact that such a condition did not exist.

The comparatively small yield on the plots fertilized with nitrogen in the form of blood leaves it still a matter of uncertainty whether nitrification took place in that instance or whether the yield was only the normal yield of those plots when supplied with the mineral elements only. Even though the blood may have furnished little or no nitrogen to the crop, it did not have an injurious effect, as was the case with the sulphate.

Whether delayed nitrification was due to the absence of the nitric ferment, or to the possible acidity of the soil and a lack of carbonate of lime, or to still other causes, we are unable to say. Should a like opportunity again afford itself, some experiments will be planned to see if the cause cannot be definitely determined and to ascertain if the condition cannot be corrected at a sufficiently early stage to save the season's crop.

Where single elements were applied (plots 1, 2 and 3) it will be noticed that a positive gain resulted in each case. (It should be remarked here that the yield on plot No. 0 was greater than the normal yield from the fact that the crop doubtless stole some fertilizer from the adjoining grain plots).

Phosphoric acid alone gave better returns than the nitrogen alone; these were both led by the potash alone, in the form of muriate. The potash and nitrogen and potash and phosphoric acid plots, (Nos. 5 and 6) were also better than the nitrogen and phosphoric acid combination (plot No. 4). These results also accord with the observations made upon the general appearance of the plots during the period of growth.

General Conclusions from the Kingston Experiment.

1. The soil appeared to be deficient in potash, phosphoric acid and nitrogen. Potash appeared to be especially lacking, next phosphoric acid and finally nitrogen.

2. Nitrogen in the form of nitrate of soda gave better results than in the form of sulphate of ammonia or dried blood.

3. Nitrogen in the form of sulphate of ammonia had a positively injurious effect, which increased with the amount applied. Little or none of the nitrogen applied in this form seems to have been appropriated by the plant.

4. Nitrogen in the form of dried blood may have been appropriated to some extent by the plant, though owing to the greater inequality of the plots on this portion of the field, positive conclusions in the matter, cannot safely be drawn.

WESTERLY, R. I.

2. Mr. Courtland P. Chapman's Experiment.

The soil was a good rich loam and slightly sandy. In 1884 the field was well fertilized with stable manure and sea-weed and planted with Indian corn. In 1885 it was fertilized with sea-weed, plowed and planted with potatoes, with "phosphate" in the hill. In the spring of 1886 it was plowed and seeded with oats; from that time until 1890 it had been regularly mowed and but lightly top dressed.

This field appeared to be in a higher state of fertility than any other under experiment.

It cannot be expected, as previously mentioned, that a large application of fertilizer upon a rich soil will prove highly profitable, though the application of a small quantity chiefly in the hill or drill for giving the crop an early start, might in such cases prove to be an economical practice. A large application in this instance, where it involved a considerable outlay for the most expensive element, (the nitrogen) did not prove generally profitable, as will be seen from the following tables.

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

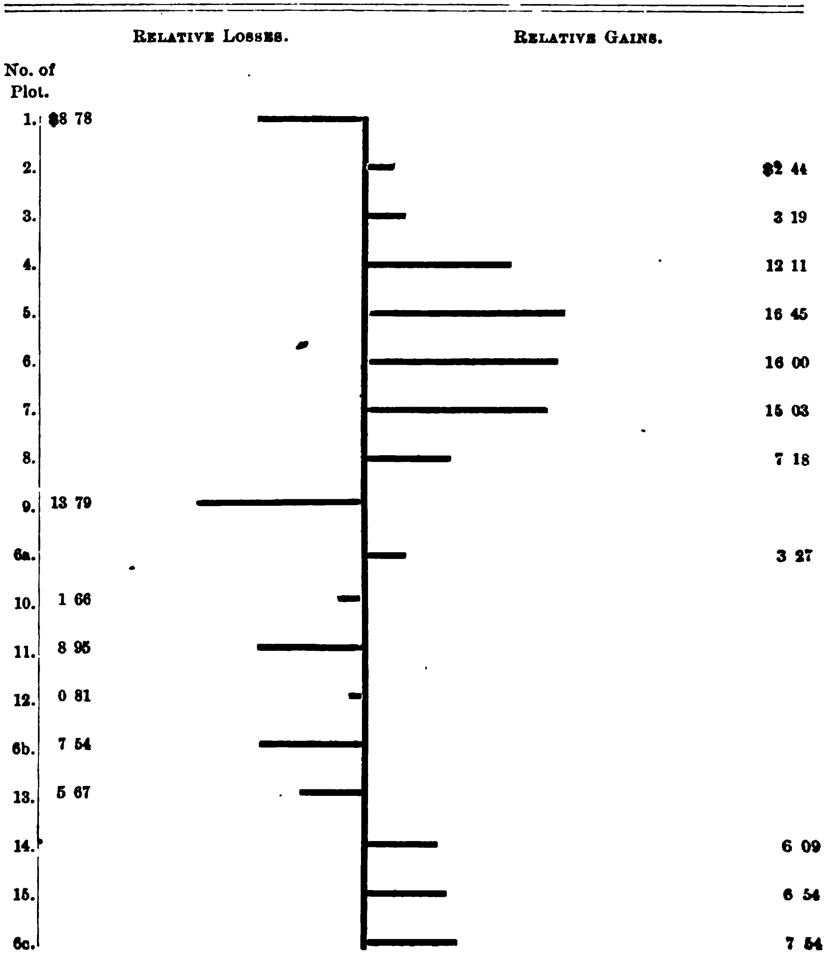
No. of Plot.	KIND OF FERTILIZER.	Total yield per Plot.			Total yield per Acre.		
		Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	228	4	120	65.14	1.14	2400
1.	Nitrate of Soda.	196	4	116	56.00	1.14	2320
2.	Dissolved Bone Black, (14 per cent. soluble acid)	242	10	140	69.14	2.85	2800
3.	Muriate of Potash	244	4	140	69.71	1.14	2800
4.	Nitrate of Soda, Dissolved Bone Black,	284	8	204	81.14	2.28	4080
5.	Nitrate of Soda, Muriate of Potash,	292	8	228	83.43	2.28	4560
6.	Dissolved Bone Black, Muriate of Potash, } Mixed Minerals,	296	8	228	84.57	2.28	4560
	NITRATE OF SODA GROUP.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration,	304	8	236	86.86	2.28	4720
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration,	292	8	212	83.43	2.28	4240
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	224	8	172	64.00	2.28	3440
6a.	Mixed Minerals as No. 6	248	8	188	70.86	2.28	3760
	SULPHATE OF AMMONIA GROUP.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration,	252	1	172	72.00	0.28	3440
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration,	236	12	156	67.43	3.42	3120
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration,	276	8	212	78.86	2.28	4240
6b.	Mixed Minerals as No. 6	208	8	156	59.43	2.28	3120
	DRIED BLOOD GROUP.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration,	236	8	152	67.43	2 28	3040
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration,	284	8	228	81.14	2.28	4560
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	300	16	228	85.71	4.57	4560
6c.	Mixed Minerals as No. 6	264	8	200	75.43	2.28	4000
00.	Nothing	196	8	156	56.00	2.28	3120

TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Stover.	Stover.	Total value per acre of corn and stover over that of the "nothing" plots.	Cost of Fertilizers per Acre.	Value of the Crop per Acre over the cost of the Fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 37½c. per bush.	lbs.	Value at $7 per ton.			
1.	—4.57	—$3 43	—0.57	—$0 21	—440	—$1 54	—$5 18	$3 60	—$8 78
2.	8.57	6 43	1.14	0 42	40	0 14	6 99	4 55	2 44
3.	9.14	6 86	—0.57	—0 21	40	0 14	6 79	3 60	3 19
4.	20.57	15 43	0.57	0 21	1320	4 62	20 26	8 15	12 11
5.	22.86	17 14	0.57	0 21	1800	6 30	23 65	7 20	16 45
6.	24.00	18 00	0.57	0 21	1800	6 30	24 15	8 15	16 00
7.	26.29	19 71	0.57	0 21	1960	6 86	26 78	11 75	15 03
8.	22.86	17 14	0.57	0 21	1480	5 18	22 53	15 35	7 18
9.	3.43	2 57	0.57	0 21	680	2 38	5 16	18 95	—13 79
6a.	10 29	7 71	0.57	0 21	1000	3 50	11 42	8 15	3 27
10.	11.43	8 57	—1.43	—0 54	680	2 38	10 41	12 07	—1 66
11.	6.86	5 14	1.71	0 64	360	1 26	7 04	15 99	—8 95
12.	18.29	13 71	0.57	0 21	1480	5 18	19 10	19 91	—0 81
6b.	—1.14	—0 86	0.57	0 21	360	1 26	0 61	8 15	—7 54
13.	6.86	5 14	0.57	0 21	280	0 98	6 33	12 00	—5 67
14.	20.57	15 43	0.57	0 21	1800	6 30	21 94	15 85	6 09
15.	25.14	18 86	2.86	1 08	1800	6 30	26 24	19 70	6 54
6c.	14.86	11 14	0.57	0 21	1240	4 34	15 69	8 15	7 54

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



By a comparison of this experiment with the preceding one, it will be seen that in general the total yields on Mr. Chapman's field were far greater than in the Station experiment, but that the gain from the use of fertilizers in the latter, were much greater than in the former instance.

From an inspection of plots 1, 2 and 3, upon which single elements were applied, it appears that potash alone produced the best results and nitrogen the poorest; in the combinations of two elements the leading plots are those where potash was one of the ingredients. Wholly reliable conclusions cannot, however, be drawn from this single experiment, conducted for one season only, for it will be noticed by a glance at the preceding tables that there seems to be considerable lack of uniformity in the plots.

General Conclusions from the Westerly Experiment.

1. From this single trial it appears that the soil lacks available potash more than phosphoric acid, though both are somewhat deficient, and that in general the application of any considerable quantity of nitrogen was not profitable.

2. That nitrogen in the form of nitrate of soda gave better results than that from sulphate of ammonia or dried blood, the latter, however, leading the sulphate.

3. That with Indian corn the application of highly nitrogenous fertilizers in large quantities on a field full of humus and grass roots and in a high state of fertility is not attended with adequate profit.

HOPE VALLEY, R. I.

3. Mr. Herbert E. Lewis' Experiment.

The soil was a sandy loam and the field had served for several years as a cow pasture. The same general method of treatment was adopted in this case as in all the other experiments.

On July 10, plots 1 and 3 were yellow and looked the worst of any on the field, No. 14 was best of all, and Nos. 10, 11, 12, 6b and 13 were very fair and the rest medium. July 26, plots 1 and 3 showed more improvement than any of the others, while the remainder, though having improved, occupied the same relative positions as on July 10. The high wind of the 1st of August blew the corn down, "breaking some of it entirely off."

On September 22, the day the corn was cut, that on plots 1, 7, 8 and 9 was quite green as compared with the rest, and plots 8, 11 and 12 presented the best appearance of any in the field.

The husking and weighing was all done on the same day. That the field was not in a high state of fertility is seen from the yield on the "nothing" plots, as shown by the following table.

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

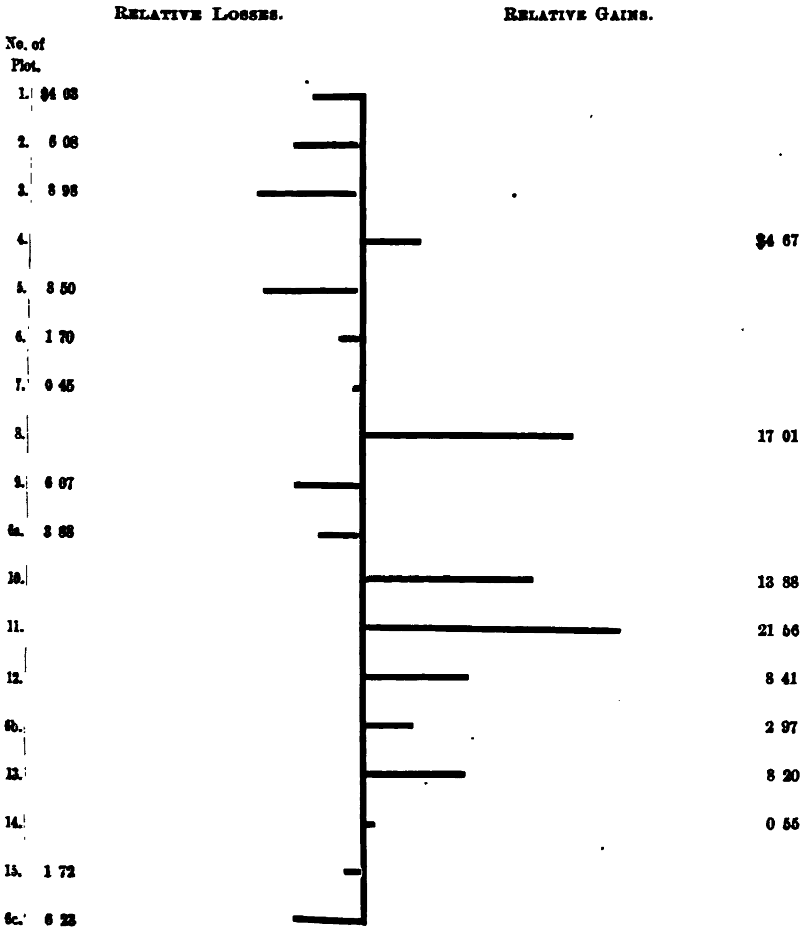
No. of Plot.	KIND OF FERTILIZER.	Total yield per Plot.			Total yield per Acre.		
		Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	75.00	16.25	72.50	21.43	4.64	1450
1.	Nitrate of Soda	73.75	21.25	88.75	21.07	6.07	1775
2.	Dissolved Bone Black (14 per cent. soluble acid)	77.50	10.00	78.75	22.14	2.86	1575
3.	Muriate of Potash	57.50	12.50	81.25	16.43	3.57	1625
4.	Nitrate of Soda, Dissolved Bone Black,	127.50	13.75	125.00	36.43	3.92	2500
5.	Nitrate of Soda, Muriate of Potash,	70.00	12.50	101.25	20.00	3.57	2025
6.	Dissolved Bone Black, Muriate of Potash, } Mixed Minerals,	97.50	17.50	120.00	27.86	5.00	2400
	NITRATE OF SODA GROUP.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration,	117.50	13 75	133.75	33.57	3.93	2675
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration,	192.50	18.75	197.50	55.00	5.36	3950
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	117.50	16.25	152.50	33.57	4.64	3050
6a.	Mixed Minerals as No. 6	91.25	13.75	113.75	26.07	3.93	2275
	SULPHATE OF AMMONIA GROUP.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration,	168.75	21.25	175.00	48.21	6.07	3500
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration,	210.00	20.00	216.25	60.00	5.71	4325
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration,	180.00	17.50	180.00	51.43	5.00	3600
6b.	Mixed Minerals as No. 6	117.50	11.25	135.00	33.57	3.21	2700
	DRIED BLOOD GROUP.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration,	157.50	11.25	142.50	45.00	3.21	2850
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration,	131.25	16.25	145.00	37.50	4.64	2900
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	143.75	16.25	145.00	41.07	4.64	2900
6c.	Mixed Minerals as No. 6	83.75	12.50	105.00	23.93	3.57	2100
00.	Nothing	80.00	27.50	92.50	22.86	7.86	1850

TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Stover.	Stover.	Total value per acre of corn and stover over that of the "nothing" plots.	Cost of Fertilizers per Acre.	Value of the Crop per Acre over the cost of the Fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 37½c. per bush.	lbs.	Value at $7 per ton.			
1.	—1.07	—$0 80	—0.18	—$0 07	125	$0 44	—$0 43	$3 60	—$4 03
2.	0.00	0 00	—3.39	—1 27	—75	—0 26	—1 53	4 55	—6 08
3.	—5.71	—4 29	—2.68	—1 00	—25	—0 09	—5 38	3 60	—8 98
4.	14.29	10 71	—2.32	—0 87	850	2 98	12 82	8 15	4 67
5.	—2.14	—1 61	—2.68	—1 00	375	1 31	—1 30	7 20	—8 50
6.	5.71	4 29	—1.25	—0 47	750	2 63	6 45	8 15	—1 70
7.	11.42	8 58	—2.32	—0 87	1025	3 59	11 30	11 75	—0 45
8.	32.86	24 64	—0.89	—0 33	2300	8 05	32 36	15 35	17 01
9.	11.42	8 58	—1.61	—0 60	1400	4 90	12 88	18 95	—6 07
6a.	3.93	2 95	—2.32	—0 87	625	2 19	4 27	8 15	—3 88
10.	26.07	19 54	—0.18	—0 07	1850	6 48	25 95	12 07	13 88
11.	37.86	28 39	—0.54	0 20	2675	9 36	37 55	15 99	21 56
12.	29.29	21 96	—1.25	—0 47	1950	6 83	28 32	19 91	8 41
6b.	11.42	8 58	—3.04	—1 14	1050	3 68	11 12	8 15	2 97
13.	22.86	17 14	—3.04	—1 14	1200	4 20	20 20	12 00	8 20
14.	15.36	11 52	—1.61	—0 60	1250	4 38	15 30	15 85	0 55
15.	18.93	14 20	—1.61	—0 60	1250	4 38	17 98	19 70	—1 72
6c.	1.79	1 34	—2.68	—1 00	450	1 58	1 92	8 15	—6 23

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



From an inspection of the table on page 63, it will be seen that of the single element plots (Nos. 1, 2 and 3) No. 2, where phosphoric acid was applied, shows the greatest yield of hard corn. In the combinations of two elements (plots 4, 5 and 6) it will also be noticed that plots 4 and 6, where phosphoric acid constituted a part of the ration, gave the greatest yields. By a further reference to the table it will be observed that nitrogen, both alone and in combination, gave better returns than potash.

Referring to the special test of the various nitrogen compounds, it will be seen that the sulphate of ammonia group (plots 10, 11 and 12) gave better yields than those with nitrogen in either of the other forms. These results stand in marked contrast to those of the Experiment Station experiment, showing that where the conditions are favorable, the sulphate of ammonia, instead of poisoning the crop, may not only act favorably but sometimes give even better results than nitrogen in the form of dried blood or nitrate of soda.

The value of the crop on two of the manured plots falls below that of the average of the "nothing" plots, which indicates more or less variation in fertility. The two plots upon which the yield fell decidedly below the stated average were, plot 3 where potash alone was applied, and plot 5 fertilized with potash and nitrogen.

In every instance where potash was applied with phosphoric acid (plots 6, 6a, 6b and 6c) a decided gain is noticeable, which in all probability was not due to the potash, but chiefly to the phosphoric acid.

From the results on the nitrate of soda, dried blood and sulphate of ammonia groups, it is evident that nitrogen was lacking, since its addition assured greater yields, but notwithstanding this, the application of nitrogen combined with potash only, was apparently without result. As has been previously stated if one essential element is lacking, the plant cannot be made to grow, though sup-

plied with an abundance of all the others. The true explanation of the low yield on plot 5 is probably to be found in the fact that the supply of available phosphoric acid was deficient. That the lack of nitrogen was less than that of phosphoric acid, is indicated by the results on plots 6, 6a, 6b and 6c, where the phosphoric acid without extra nitrogen produced considerable additional yield, the potash in this case adding little if anything to the crop.

From the result on plot 3 it might seem, as was actually the case in the use of large amounts of sulphate of ammonia in the Experiment Station experiment, that the application of potash alone actually injured the crop, though the data in this instance are not sufficient to justify such a conclusion.

It will be noticed that the largest yields and the greatest profits are from those plots where nitrogen was added to the mixed minerals. In only one instance (plot 6b), where potash was applied in combination with but one other element did the value of the additional crop cover the cost of the fertilizer. By the combination of phosphoric acid and nitrogen (plot 4) the total value of the crop over the average value of the "nothing" plots amounts to $12.82, while that of plot 5, with a combination of potash and nitrogen, is $1.30 below the average, making a total difference in value of $14.12 between the two plots.

General Conclusions from the Hope Valley Experiment.

1. The soil in this instance appears to have been decidedly deficient in phosphoric acid and considerably so in nitrogen.

2. The application of potash in any considerable quantity was apparently not accompanied with profit.

3. The use of nitrogen in connection with phosphoric acid gave profitable returns and vice versa.

4. Phosphoric acid alone or in combination with potash gave better returns than nitrogen alone, or nitrogen and potash.

NOOSENECK, R. I.

4. Mr. J. B. Vaughn's Experiment.

The soil was a poor and sandy loam and the field had not been planted or fertilized since 1884; the crop grown at that time being fodder-corn manured in the drill.

In many places there was little or no sod, and at the time the field was surveyed and plotted there was almost nothing growing upon it save bluets (Houstonia cærulea) and bird-foot violets (Viola pedeta).

Several isolated clusters of the common blue lupine (Lupinus perennis) were to be seen growing profusely. This plant is generally found on neglected, sandy fields and by sandy road-sides, and belongs to the family of plants known as the "Leguminosæ," the lupine and several other members of which have been shown by Atwater, Hellriegel and others to be able to draw their supply of nitrogen largely from the air.

As will be seen from the tables which follow, this soil appeared to be decidedly deficient in nitrogen, but, nevertheless, the lupine, one of the class of plants richest of all in nitrogen, was able to attain perfect development. This was a good object lesson, showing that Nature provides for herself, for this plant was at work probably gathering nitrogen from the air and thus furnishing to the soil by its decay the most costly of the lacking elements. To the same end other of the lupines, the horse-bean and cow-pea have been introduced for use in green manuring.

TABLE SHOWING THE KIND OF FERTILIZER AND YIELD PER PLOT AND PER ACRE.

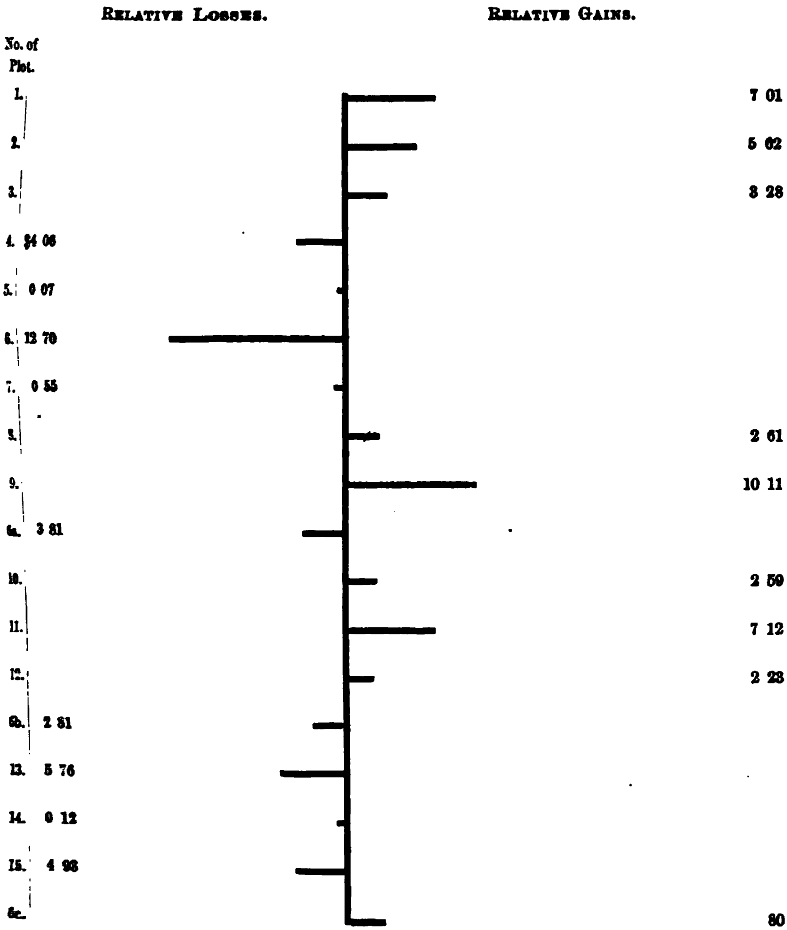
No. of Plot.	Kind of Fertilizer.	Total yield per Plot.			Total yield per Acre.		
		Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	53.75	17.50	55.0	15.36	5.00	1100
1.	Nitrate of Soda	120.00	10.00	72.5	34.28	2.86	1450
2.	Dissolved Bone Black (14 per cent. soluble acid)	120.00	7.50	70.0	34.28	2.14	1400
3.	Muriate of Potash	105.00	10.00	65.0	30.00	2.86	1300
4.	Nitrate of Soda, Dissolved Bone Black,	90.00	7.50	75.0	25.71	2.14	1500
5.	Nitrate of Soda, Muriate of Potash,	100.00	12.50	80.0	28.57	3.57	1600
6.	Dissolved Bone Black, Muriate of Potash, } Mixed Minerals,	55.00	10.00	55.0	15.71	2.86	1100
	NITRATE OF SODA GROUP.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration,	115.00	7.50	100.0	32.86	2.14	2000
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration,	137.50	12.50	120.0	39.28	3.57	2400
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	175.00	15.00	160.0	50.00	4.28	3200
6a.	Mixed Minerals as No. 6	85.00	10.00	90.0	24.28	2.86	1800
	SULPHATE OF AMMONIA GROUP.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration,	125.00	10.00	115.0	35.71	2.86	2300
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ratien,	155.00	12.50	140.0	44.28	3.57	2800
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration,	155.00	10.00	130.0	44.28	2.86	2600
6b.	Mixed Minerals as No. 6	95.00	7.50	77.5	27.14	2.14	1550
	DRIED BLOOD GROUP.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration,	100.00	7.50	75.0	28.57	2.14	1500
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration,	127.50	15.00	115.0	36.43	4.28	2300
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	127.50	10.50	105.0	36.43	3.57	2100
6c.	Mixed Minerals as No. 6	120.00	5.00	85.0	34.28	1.43	1700
00.	Nothing	90.00	10.00	70.0	25.71	2.86	1400

TABLE SHOWING THE IMCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Stover.		Total value per acre of corn and stover over that of the "nothing" plots.	Cost of Fertilizers per Acre.	Value of the Crop per Acre over the cost of the Fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 37½c. per bush.	lbs.	Value at $7 per ton.			
1.	13.75	$10 31	—1.07	—$0 40	200	$0 70	$10 61	$3 60	$7 01
2.	13.75	10 31	—1.79	—0 67	150	0 53	10 17	4 55	5 62
3.	9.46	7 10	—1.07	—0 40	50	0 18	6 88	3 60	3 28
4.	5.18	3 88	—1.79	—0 67	250	0 88	4 09	8 15	—4 06
5.	8.04	6 03	—0.36	—0 13	350	1 23	7 13	7 20	—0 07
6.	—4.82	—3 62	—1.07	—0 40	—150	—0 53	—4 55	8 15	—12 70
7.	12.32	9 24	—1.79	—0 67	750	2 63	11 20	11 75	—0 55
8.	18.75	14 06	—0.36	—0 13	1150	4 03	17 96	15 35	2 61
9.	29.46	22 10	0.36	0 13	1950	6 83	29 06	18 95	10 11
6a.	3.75	2 81	—1.07	—0 40	550	1 93	4 34	8 15	—3 81
10.	15.18	11 38	—1.07	—0 40	1050	3 68	14 66	12 07	2 59
11.	23.75	17 81	—0.36	—0 13	1550	5 43	23 11	15 99	7 12
12.	23.75	17 81	—1.07	—0 40	1350	4 73	22 14	19 91	2 23
6b.	6.61	4 96	—1.79	—0 67	300	1 05	5 34	8 15	—2 81
13.	8.04	6 03	—1.79	—0 67	250	0 88	6 24	12 00	—5 76
14.	15.89	11 92	0.36	0 13	1050	3 68	15 73	15 85	—0 12
15.	15.89	11 92	—0.36	—0 13	850	2 98	14 77	19 70	—4 93
6c.	13.75	10 31	—2.50	—0 94	450	1 58	10 95	8 15	2 80

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



The field, as will be seen from a casual glance at the yield upon the various plots, was not uniformly fertile, for plots 1 and 2, each supplied with a single element, gave greater yields than other plots receiving the same amount together with an additional element (plots 4, 5 and 6).

That there was a certain deficiency of all the elements, is shown by the fact that in every instance but one (plot 6) the application of fertilizers, whether simple or compound, was accompanied by an increased yield. The largest yields were upon those plots where nitrogen was added to the potash and phosphoric acid (mixed minerals) ration, and in the case of the sulphate of ammonia and nitrate of soda groups the addition of extra nitrogen was accompanied by profit in every instance but one, (plot 7) where only a ⅛ ration was added.

So far as the eye could detect there was little difference between the nitrate of soda and the sulphate of ammonia groups, other than that the latter plots were not so mature as the former. This difference is easily explained upon the assumption that the nitrate of soda furnished nitrogen in a form directly available to the plant so that growth and development was not delayed, while that of the sulphate having first to undergo the process of nitrification, prolonged the period of growth.

The total yield from the plots of the dried blood group was not only less than that from those of the preceding nitrogen groups, but it will also be seen that the use of fertilizers upon each of these plots was accompanied by a financial loss.

The profit from the use of nitrogenous fertilizers in this experiment stands in marked contrast to the results of Mr. Chapman's experiment at Westerly, where any considerable application of nitrogen resulted in a loss.

The application of mixed minerals alone proved profitable in but one instance, (plot 6c) notwithstanding the fact that the cost

of the same was comparatively low, but when used in connection with nitrogen, though the cost was thereby greatly increased, it nevertheless resulted in profit.

General Conclusions from the Nooseneck Experiment.

1. Nitrogen, phosphoric acid and potash were all lacking, though more especially nitrogen.

2. Nitrogen, in the form of nitrate of soda and sulphate of ammonia, gave better returns than in the form of dried blood, and its application, even in considerable quantities in the two former cases, was accompanied with profit, and in the latter case with loss.

3. The corn upon the plots supplied with nitrogen in the form of sulphate of ammonia, was later in maturing than that where nitrogen in the form of nitrate of soda was used.

4. Potash and phosphoric acid applied alone proved unprofitable, which was not the case when combined with nitrogen in the most available form.

LIME ROCK, R. I.

5. Mr. H. Hartwell Jencks' Experiment.

The soil in this instance was a dark loam. One end of plots 15, 6c and 00 was quite wet at the time the field was plotted and was not adapted to Indian corn except in a dry season.

In 1888 the field was planted with beans and potatoes, "with a little barn-yard manure in the hill." "Prior to being planted the field had been in grass for a long time and was pretty well run out, producing only about one ton of hay to the acre."

This year's results are given more especially for the purpose of comparison, in case the experiment is continued, than on account of any definite conclusions that may be drawn from the results of the past season's experiment.

The yields and results were as follows :

TABLE SHOWING THE KIND OF FERTILIZER AND YIELD PER PLOT AND PER ACRE.

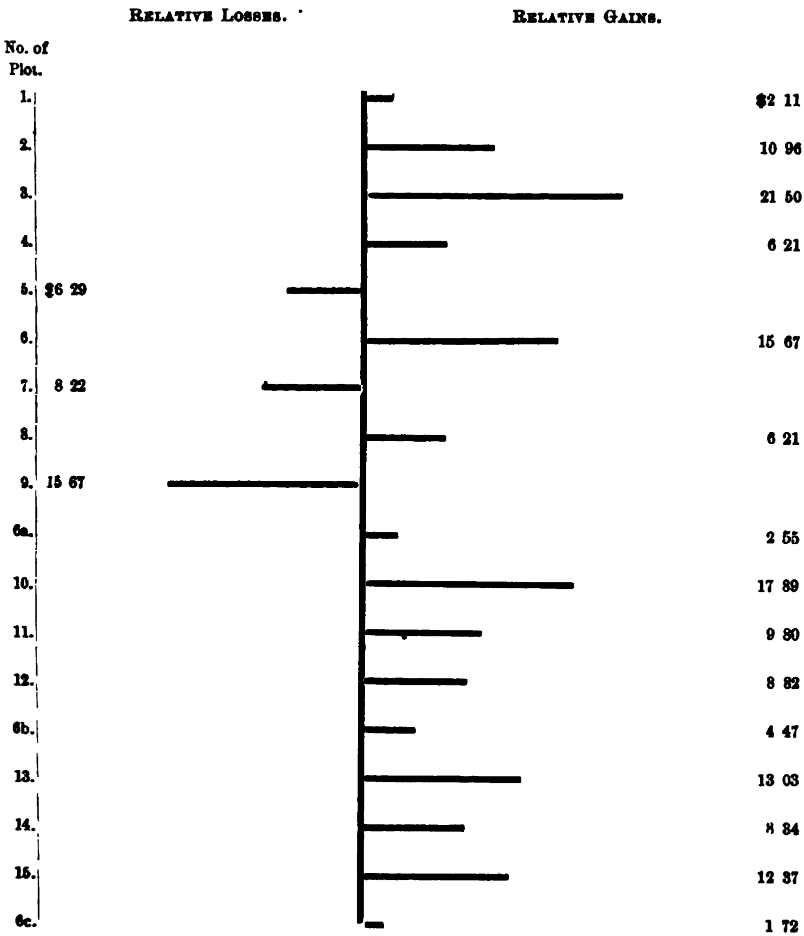
No. of Plot.	Kind of Fertilizer.	Total yield per Plot.			Total yield per Acre.		
		Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	153.30	17.4	306.5	43.80	4.97	6130
1.	Nitrate of Soda	162.75	15.0	350.0	46.50	4.28	7000
2.	Dissolved Bone Black, (14 per cent. soluble acid)	197.63	4.0	400.0	56.48	1.14	8000
3.	Muriate of Potash	240.10	13.4	392.5	68.60	3.82	7850
4.	Nitrate of Soda, Dissolved Bone Black,	205.60	7.6	353.7	58.74	2.17	7074
5.	Nitrate of Soda, Muriate of Potash,	157.13	14.0	300.0	44.90	4.00	6000
6.	Dissolved Bone Black, Muriate of Potash, Mixed Minerals,	227.90	7.2	421.2	65.11	2.06	8424
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration,	139.50	4.5	406.0	39.86	1.28	8120
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration,	226.70	3.3	398.5	64.77	0.94	7970
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	141.70	16.1	378.0	40.49	4.60	7560
6a.	Mixed Minerals as No. 6	163.50	20.4	410.7	46.71	5.82	8214
	Sulphate of Ammonia Group.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration,	250.70	10.1	434.6	71.63	2.83	8692
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration,	235.20	11.1	422.2	67.20	3.17	8444
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration,	252.40	13.4	407.0	72.11	3.83	8140
6b.	Mixed Minerals as No. 6	204.30	18.1	316.7	58.37	5.17	6334
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration,	224.30	18.2	432.6	64.09	5.20	8652
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration,	232.50	10.0	408.0	66.43	2.86	8160
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	267.10	7.3	418.8	76.31	2.09	8376
6c.	Mixed Minerals as No. 6	194.30	13.7	317.9	55.23	3.91	6358
00.	Nothing	155.40	8.8	287.5	44.40	2.51	5750

TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Stover.		Total value per acre of corn and stover over that of the "nothing" plots.	Cost of Fertilizers per Acre.	Value of the Crop per Acre over the cost of the Fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 37½c. per bush.	lbs.	Value at $7 per ton.			
1.	2.40	$1 80	0.54	$0 20	1060	$3 71	$5 71	$3 60	$2 11
2.	12.37	9 28	—2.60	—0 98	2060	7 21	15 51	4 55	10 96
3.	24.50	18 38	0.09	0 03	1910	6 69	25 10	3 60	21 50
4.	14.64	10 98	—1.57	—0 59	1134	3 97	14 36	8 15	6 21
5.	0.80	0 60	0.26	0 10	60	0 21	0 91	7 20	—6 29
6.	21.01	15 76	—1.69	—0 63	2484	8 69	23 82	8 15	15 67
7.	—4.24	—3 18	—2.46	—0 92	2180	7 63	3 53	11 75	—8 22
8.	20.67	15 50	—2.80	—1 05	2030	7 11	21 56	15 35	6 21
9.	—3.61	—2 17	0.85	0 32	1620	5 67	3 28	18 95	—15 67
6a.	2.61	1 96	2.09	0 78	2274	7 96	10 70	8 15	2 55
10.	27.53	20 65	—0.85	—0 32	2752	9 63	29 96	12 07	17 89
11.	23.10	17 24	—0.57	—0 21	2504	8 76	25 79	15 99	9 80
12.	28.01	21 00	0.09	0 03	2200	7 70	28 73	19 91	8 82
6b.	14.27	10 70	1.43	0 54	394	1 38	12 62	8 15	4 47
13.	19.99	14 99	1.46	0 55	2712	9 49	25 03	12 00	13 03
14.	22.33	16 75	—0.89	—0 33	2220	7 77	24 19	15 85	8 34
15.	32.21	24 16	—1.66	—0 62	2436	8 53	32 07	19 70	12 37
6c.	11.13	8 35	0.17	0 06	418	1 46	9 87	8 15	1 72

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



It will be seen that the addition of nitrogen alone (plot 1) gave an apparent increase, phosphoric acid alone (plot 2) a somewhat greater one, and potash alone (plot 3) greater than either of the preceding. From this, one would be led to expect better results from the combination of nitrogen and phosphoric acid than from nitrogen and potash, and that potash and phosphoric acid combined would give the best results of all. This is, in fact, exactly what has resulted in the case of the various combinations on plots 4, 5 and 6. The striking variations on the succeeding plots debar one, however, from accepting the above results as due solely to the fertilizers, since they may be due to chance and the pre-existing differences in the plots. In support of this idea it will be observed that plots 7 and 8, upon which a like amount of potash and phosphoric acid was applied as upon the four "mixed mineral" plots, have given smaller yields, notwithstanding the presence of additional nitrogen. That the nitrogen in this case did not injure the crop, as resulted in the use of sulphate of ammonia in the Kingston experiment, is concluded from the fact that the other plots, 1, 4, 5 and 8, upon which nitrogen in the form of nitrate of soda was used, were not similarly affected.

The yields upon the individual plots, of the sulphate of ammonia and dried blood groups, when compared with the yields on plots 6a, 6b and 6c, justify the conclusions that nitrogen in both of these forms, applied in addition to the mixed minerals, considerably increased both the total yields and the net profits. This field being situated in a lime-stone region was probably not deficient in carbonate of lime, and hence this important element in hastening the process of nitrification was doubtless not lacking. The facts in this experiment admit of but few generalizations, though they may serve an important purpose in explaining future results.

General Conclusions from the Lime Rock Experiment.

1. Nitrogen in the form of sulphate of ammonia and dried blood, when used in connection with potash and phosphoric acid, increased both the total yield and the net profit.

2. The low yield upon two of the plots (plots 7 and 8) in the nitrate of soda group, does not admit of ready explanation, except upon the ground of great variations in the natural fertility of the individual plots.

3. To a certain extent there appears to have been a deficiency of all the elements, the lack of nitrogen being more especially noticeable in the results upon the sulphate of ammonia and dried blood groups.

4. Potash appears to have been more deficient than the phosphoric acid, though in view of the inequality of the plots we do not feel justified in drawing positive conclusions from the results of a single experiment.

ABBOTT RUN, R. I.

6. Mr. E. F. Crowninshield's Experiment.

The soil upon this field was a light, sandy loam.

The field was first plowed and sowed to winter rye, followed by a crop of buckwheat, which was turned under and fertilizers applied freely. Indian corn was now planted, which proved a failure, and this was succeeded by a crop of "round turnips." In 1889 fertilizer was again applied, and a fair crop of "Hungarian" was grown. No barn-yard manure was ever used on the field. The land was plowed to a depth of about four inches.

The following are the tabulated results:

TABLE SHOWING THE KIND OF FERTILIZER AND YIELD PER PLOT AND PER ACRE.

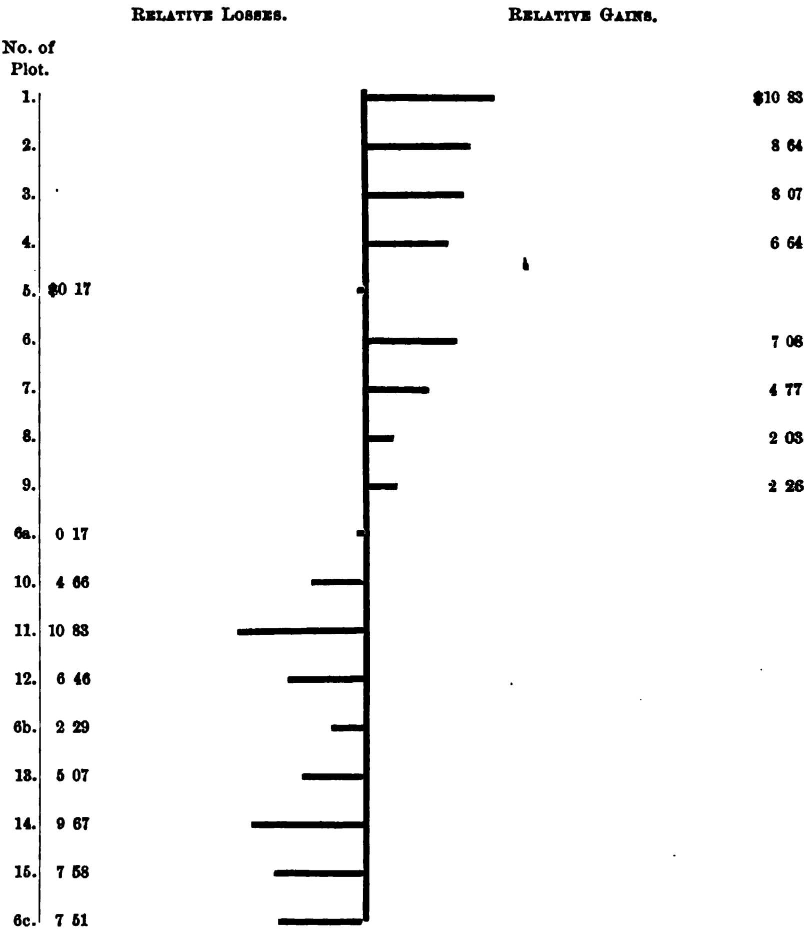
No. of Plot.	KIND OF FERTILIZER.	Total yield per Plot.			Total yield per Acre.		
		Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	50.00	15.00	35.0	14.28	4.28	700
1.	Nitrate of Soda	115.00	7.50	55.0	32.86	2.14	1100
2.	Dissolved Bone Black (14 per cent. soluble acid)	110.00	7.50	52.5	31.43	2.14	1050
3.	Muriate of Potash	105.00	5.00	50.0	30.00	1.43	1000
4.	Nitrate of Soda, Dissolved Bone Black,	117.50	7.50	52.5	33.57	2.14	1050
5.	Nitrate of Soda, Muriate of Potash,	85.00	5.00	45.0	24.28	1.43	900
6.	Dissolved Bone Black, Muriate of Potash, } Mixed Minerals,	120.00	5.00	55.0	34.28	1.43	1100
	NITRATE OF SODA GROUP.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration,	125.00	3.75	60.0	35.71	1.07	1200
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration,	130.00	5.00	55.0	37.14	1.43	1100
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	145.00	7.50	60.0	41.43	2.14	1200
6a.	Mixed Minerals as No. 6	87.50	8.75	45.0	25.00	2.50	900
	SULPHATE OF AMMONIA GROUP.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration,	82.50	15.00	42.5	23.57	4.28	850
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration,	70.00	17.50	45.0	20.00	5.00	900
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration,	105.00	15.00	60.0	30.00	4.28	1200
6b.	Mixed Minerals as No. 6	75.00	7.50	55.0	21.43	2.14	1100
	DRIED BLOOD GROUP.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration,	80.00	7.50	55.0	22.86	2.14	1100
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration,	75.00	8.75	57.5	21.43	2.50	1150
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	105.00	7.50	52.5	30.00	2.14	1050
6c.	Mixed Minerals as No. 6	52.50	3.75	55.0	15.00	1.07	1100
00.	Nothing	55.00	5.00	37.5	15.71	1.43	750

TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Stover.		Total value per acre of corn and stover over that of the "nothing" plots.	Cost of Fertilizers per Acre.	Value of the Crop per Acre over the cost of the Fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 87½c. per bush.	lbs.	Value at $7 per ton.			
1.	17.85	$13 39	—0.71	—$0 27	375	$1 31	$14 43	$3 60	$10 83
2.	16.43	12 32	—0.71	—0 27	325	1 14	13 19	4 55	8 64
3.	15.00	11 25	—1.43	—0 54	275	0 96	11 67	3 60	8 07
4.	18.57	13 92	—0.71	—0 27	325	1 14	14 79	8 15	6 64
5.	9.28	6 96	—1.43	—0 54	175	0 61	7 03	7 20	—0 17
6.	19.28	14 46	—1.43	—0 54	375	1 31	15 23	8 15	7 08
7.	20.71	15 53	—1.79	—0 67	475	1 66	16 52	11 75	4 77
8.	22.14	16 61	—1.43	—0 54	375	1 31	17 38	15 35	2 03
9.	26.43	19 82	—0.71	—0 27	475	1 66	21 21	18 95	2 26
6a.	10.00	7 50	—0.36	—0 13	175	0 61	7 98	8 15	—0 17
10.	8.57	6 43	1.43	0 54	125	0 44	7 41	12 07	—4 66
11.	5.00	3 75	2.14	0 80	175	0 61	5 16	15 99	—10 83
12.	15.00	11 25	1.43	0 54	475	1 66	13 45	19 91	—6 46
6b.	6.43	4 82	—0.71	—0 27	375	1 31	5 86	8 15	—2 29
13.	7.86	5 89	—0.71	—0 27	375	1 31	6 93	12 00	—5 07
14.	6.43	4 82	—0.36	—0 13	425	1 49	6 18	15 85	—9 67
15.	15.00	11 25	—0.71	—0 27	325	1 14	12 12	19 70	—7 58
6c.	0.00	0 00	—1.79	—0 67	375	1 31	0 64	8 15	—7 51

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



From an observation of the product of the mixed mineral plots (plots 6, 6a, 6b and 6c), it is apparent that the fertility of the field diminished in the direction of plot 00. The smaller yields may have been due in this instance to the fact that that section of the field was more deficient in nitrogen than the other, for had this been the case, no amount of mixed minerals (potash and phosphoric acid) could have produced any decided gain without the addition of nitrogen. We observe, however, that nitrogen was added in the three groups of plots covering this area, but that the most marked gains were made upon plots 7, 8 and 9, where it was applied in the form of nitrate of soda. But little difference is apparent in the yields upon the sulphate of ammonia and dried blood groups. It is possible that the process of nitrification was not active enough for the plant to get the benefit from the nitrogen which had been added in these forms, and that the yield would have been greater had nitrogen in the form of nitrate of soda been employed throughout.

By an inspection of the single element groups (plots 1, 2 and 3), nitrogen seems to have given the greatest yield or to have been most deficient; phosphoric acid stands next, and finally potash. From this it would be expected that nitrogen and phosphoric acid would give better results than either of the other combinations. This is the fact so far as concerns the combination of nitrogen and potash, but the result on plot 6, with a combination of phosphoric acid and potash, apparently fails to harmonize with this, though it is possible that this plot may have stolen some nitrogen from its neighbors, or that it was originally more fertile.

General Conclusions from the Abbott Run Experiment.

1. The greatest deficiency seems to have been in nitrogen, next phosphoric acid, and finally potash, but before drawing definite conclusions the experiment should be repeated.

2. Nitrogen in the form of nitrate of soda gave better results than as sulphate of ammonia or dried blood, and its addition to the mixed mineral ration resulted in a profit only in the first mentioned form.

3. The apparent profit from the use of single constituents only, (plots 1, 2 and 3) and in fact the returns upon that entire portion of the field may have been due in some measure to the greater fertility of that section.

JAMESTOWN, R. I. (North End.)

7. Mr. Thomas A. H. Tefft's Experiment.

This soil was a black loam. The field had been in grass for forty years and had received no top-dressing in any form for seven or eight years, excepting across one corner of plots 0, 1, 2 and 3, where eel-grass had been applied six years previous to the time this experiment was undertaken. The land was plowed to a depth of four and one-half inches. On May 21, the time the field was surveyed and plotted, one end of the 00 plot and also small sections on the ends of three or four of the adjoining plots, were partially submerged in water. This section was naturally too wet for the crop, but in harvesting, as was done in several other experiments, a given part of the whole plot upon a section representing the normal yield, was weighed, and the weights for the whole plot were calculated from this.

The records of yields, etc., are given in the following tables:

TABLE SHOWING THE KIND OF FERTILIZER AND YIELD PER PLOT AND PER ACRE.

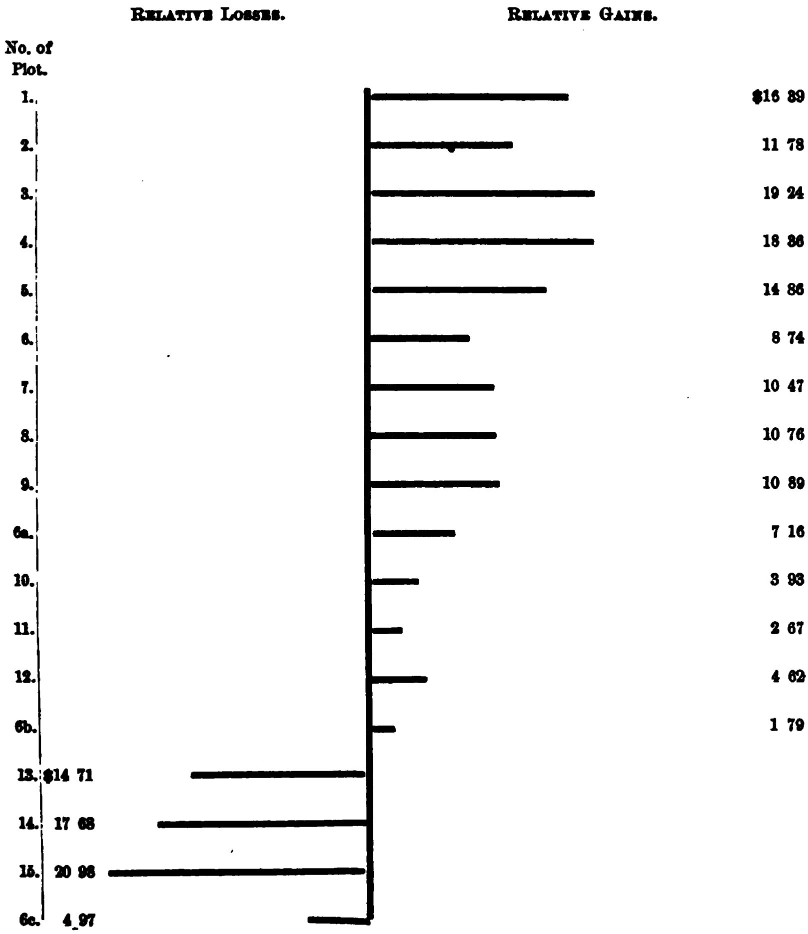
No. of Plot.	Kind of Fertilizer.	Total yield per Plot.			Total yield per Acre.		
		Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing..........................	175	70.0	145.0	50.00	20.00	2900
1.	Nitrate of Soda.....	215	57.5	185.0	61.43	16.43	3700
2.	Dissolved Bone Black (14 per cent. soluble acid)....................	200	50.0	190.0	57.14	14.28	3800
3.	Muriate of Potash	230	45.0	198.8	65.71	12.86	3975
4.	Nitrate of Soda, Dissolved Bone Black, }	245	55.0	190.0	70.00	15.71	3800
5.	Nitrate of Soda, Muriate of Potash, }	225	60.0	180.0	64.28	17.14	3600
6.	Dissolved Bone Black, Muriate of Potash, } Mixed Minerals,	200	65.0	175.0	57.14	18.57	3500
	NITRATE OF SODA GROUP.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration, }	230	45.0	190.0	65.71	12.86	3800
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration, }	245	35.0	215.0	70.00	10.00	4300
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration, }	255	40.0	230.0	72.86	11.43	4600
6a.	Mixed Minerals as No. 6..........	195	70.0	160.0	55.71	20.00	3200
	SULPHATE OF AMMONIA GROUP.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration, } ..	200	60.0	170 0	57.14	17.14	3400
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration, } ..	210	55.0	185.0	60.00	15.71	3700
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration, }	230	60.0	200.0	65.71	17.14	4000
6b.	Mixed Minerals as No. 6..........	170	70.0	160.0	48.57	20.00	3200
	DRIED BLOOD GROUP.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration, }	130	45.0	140.0	37.14	12.86	2800
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration, }	135	40.0	145.0	38.57	11.43	2900
15.	Mixed Minerals as No. 6, Dried Blood, full Ration, }	130	55.0	145.0	37.14	15.71	2900
6c.	Mixed Minerals as No. 6..........	155	45.0	147.5	44.28	12.86	2950
00.	Nothing..........................	120	25.0	97.5	34.28	7.14	1950

TABLE SHOWING THE IMCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Stover.		Total value per acre of corn and stover over that of the "nothing" plots.	Cost of Fertilizers per Acre.	Value of the Crop per Acre over the cost of the Fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 87½c. per bush.	lbs.	Value at $7 per ton.			
1.	19.28	$14 46	2.86	$1 07	1275	$4 46	$19 99	$3 60	$16 39
2.	15.00	11 25	0.71	0 27	1375	4 81	16 33	4 55	11 78
3.	23.57	17 68	—0.71	—0 27	1550	5 43	22 84	3 60	19 24
4.	27.86	20 89	2.14	0 81	1375	4 81	26 51	8 15	18 36
5.	22.14	16 61	3.57	1 34	1175	4 11	22 06	7 20	14 86
6.	15.00	11 25	5.00	1 88	1075	3 76	16 89	8 15	8 74
7.	23.57	17 68	—0.71	—0 27	1375	4 81	22 22	11 75	10 47
8.	27.86	20 89	—3.57	—1 34	1875	6 56	26 11	15 35	10 76
9.	30.71	23 04	—2.14	—0 81	2175	7 61	29 84	18 95	10 89
6a.	13.57	10 19	6.43	2 41	775	2 71	15 31	8 15	7 16
10.	15.00	11 25	3.57	1 34	975	3 41	16 00	12 07	3 93
11.	17.86	13 39	2.14	0 81	1275	4 46	18 66	15 99	2 67
12.	23.57	17 68	3.57	1 34	1575	5 51	24 53	19 91	4 62
6b.	6.43	4 82	6.43	2 41	775	2 71	9 94	8 15	1 79
13.	—5.00	—3 75	—0.71	—0 27	375	1 31	—2 71	12 00	—14 71
14.	—3.57	—2 68	—2.14	—0 81	475	1 66	—1 83	15 85	—17 68
15.	—5.00	—3 75	2.14	0 81	475	1 66	—1 28	19 70	—20 98
6c.	2.14	1 61	—0.71	—0 27	525	1 84	3 18	8 15	—4 97

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



From an inspection of the yields on the "nothing" and on the "mixed mineral" plots (6, 6a, 6b and 6c), it is evident that the fertility of the field decreased in the direction from plot 0 toward plot 00. That the soil was deficient in all three of the necessary ingredients there seems to be no doubt. On the single element plots, potash gave the greatest yield, nitrogen next, and finally phosphoric acid, though in the combination of elements the nitrogen and phosphoric acid combination (plot 4) is better than the nitrogen and potash. It is the same with this experiment as with several of the others, viz: the variation in the natural fertility of the several plots renders it impossible to conclude definitely which elements were most deficient. By a comparison of the yields on the mixed mineral plots (Nos. 6, 6a, 6b and 6c) with that on those composing the nitrate of soda group (plots 7, 8 and 9), it will be seen that the addition of nitrogen to the mixed minerals, even in considerable quantity, was accompanied by a considerable profit when applied in the form of nitrate of soda.

The addition of nitrogen, in the form of sulphate of ammonia, to the mixed minerals, considerably increased the yield, though not so much as the nitrate, and the profits were consequently less. This, perhaps, may be due to some extent, to the difference in the soil. For some reason, the addition of dried blood to the mixed minerals (plots 13, 14 and 15) seems to have had a positively injurious effect, since the yields upon these plots are smaller than upon the plots with mixed minerals only, which were located immediately before and after this group. As to the probable cause of this we are not ready to express any opinion. That nitrification may have been seriously delayed at the outset by the excessive moisture over a portion of the plot, is at least probable, but this furnishes no explanation why these plots should not have done as well as the adjoining ones, which were supplied with the same amount of everything excepting the dried blood. In this experi-

ment, and also that at Abbott Run, it will be noticed that the amount of soft corn is greater on the sulphate of ammonia plots than on those of either the dried blood or nitrate of soda groups. This probably finds its explanation on the ground that, for some reason, the nitrogen of the sulphate was not so rapidly rendered available to the plant, and that in consequence of this, the period of growth was lengthened at the expense of the maturity of the crop. In a climate like ours, where there is a great liability to early frosts, and where a difference of a week or ten days in the time of maturity seriously affects the profits, the argument for the use of nitrogen, in the form of nitrate of soda, and in general of quickly acting fertilizers, is one worthy of consideration.

General Conclusions from the Jamestown (North End) Experiment.

1. This soil appears to lack all three of the essential ingredients, but more especially nitrogen. Which of the two ingredients—potash and phosphoric acid—is more especially lacking cannot be concluded from this single experiment.

2. Nitrogen in the form of nitrate of soda gave the best results.

3. Nitrogen in the form of sulphate of ammonia, though not equal to the nitrate, gave very fair returns; the crop was, however, somewhat later in maturing.

4. Nitrogen in the form of dried blood appears in this instance not only not to have produced any beneficial results, but its presence seems for some reason to have counteracted in some measure the good effect of the mixed minerals to which it was added.

5. In general the application of chemicals in this experiment increased both the total crop and net profits.

SUMMIT, R. I.

8. Capwell & Tillinghast's Experiment.

This field constituted a part of an old pasture which had not been plowed for twenty-five years. The exposure was a southerly one. The soil upon plots 1, 2 and 3 was a light loam, and that of the following ones was gravelly, excepting plot 00, which was a sandy loam. The field was plowed to a depth of seven inches and rolled before harrowing. The season was at first too cold and wet, especially for the more loamy plots. The growth upon each plot was in general very even throughout, though great variations were noticeable in the individual plots. This was especially the case early in the season. Plots 6, 6a, 6b and 6c, were lighter in color throughout the season. Plots 10, 11, 12, 13, 14 and 15, were darker green than the others.

The following notes were taken at the time of husking:

Plots.

0. Very small, both corn and stover.
1. Corn and stover, slightly larger and better.
2. Corn lighter in color.
3. Corn quite uneven in size, shape and color.
4. Very even and well matured.
5. Paler in color and somewhat uneven in size.
6. Quite even in size; not quite as well ripened.
7. Ears not so large; short and sound.
8. Large ears, well ripened, handsome.
9. About the same, except larger yield.

6a. Short stalks, good corn.

10. Corn very handsome, stalks large.

11. Very little difference, stover heavy, color very green.

12. Stover tall, not large stalked, two ears on a stalk quite frequently; not quite so even in size.

6b. Small, rather uneven.

13. Stover good size; corn large ears, even in size and color.

14. Very much like 13, except in quantity, which was greater.

15. About the same, very handsome.

6c. Sound and well ripened.

00. Good. This plot had the advantage of better soil, it lying so as to receive the wash from other parts of the pasture.

In this case, the second and third tables are omitted, from the fact of the existence of such wide variations in the nothing plots, and owing to the fact of the unusual increase in the natural fertility of the plots over at least one-half of the field in the direction from plot 0 toward 00.

The following are the tabulated yields:

TABLE SHOWING THE KIND OF FERTILIZER AND YIELD PER PLOT AND PER ACRE.

No. of Plot.	Kind of Fertilizer.	Total yield per Plot. Hard Corn on the cob.	Total yield per Plot. Soft Corn on the cob.	Total yield per Plot. Stover.	Total yield per Acre. Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Total yield per Acre. Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Total yield per Acre. Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	18.25	15.50	33.75	5.21	4.43	675
1.	Nitrate of Soda	29.00	25.00	52.25	8.28	7.14	1045
2.	Dissolved Bone Black (14 per cent. soluble acid)	63.75	17.50	53.25	18.21	5.00	1065
3.	Muriate of Potash	45.50	19.25	58.75	13.00	5.50	1175
4.	Nitrate of Soda, Dissolved Bone Black,	106.25	16.00	80.00	30.36	4.57	1600
5.	Nitrate of Soda, Muriate of Potash,	59.75	12.00	67.25	17.07	3.43	1345
6.	Dissolved Bone Black, Muriate of Potash, } Mixed Minerals,	105.00	16.25	79.25	30.00	4.64	1585
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration,	110.00	10.00	73.25	31.43	2.86	1465
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration,	129.50	12.50	87.25	37.00	3.57	1745
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	144.00	14.00	95.25	41.14	4.00	1905
6a.	Mixed Minerals as No. 6	143.75	10.25	89.25	41.07	2.93	1785
	Sulphate of Ammonia Group.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration,	171.75	8.25	111.25	49.07	2.36	2225
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration,	173.50	9.25	125.25	49.57	2.64	2505
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration,	168.75	13.00	120.75	48.21	3.71	2415
6b.	Mixed Minerals as No. 6	138.14	9.02	82.73	39.47	2.57	1655
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration,	165.25	5.75	105.25	47.21	1.64	2105
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration,	178.75	5.25	105.25	51.07	1.50	2105
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	175.50	9.50	107.25	50.14	2.71	2145
6c.	Mixed Minerals	139.00	4.00	81.75	39.71	1.14	1635
00.	Nothing	133.00	20 00	80.00	38.00	5.71	1600

A casual inspection of the above yields, shows a deficiency of all three of the essential ingredients. That this soil needs phosphoric acid more than potash or nitrogen there seems in this case to be no question. Among the single ingredient plots, plot 2, receiving phosphoric acid, leads both of the others. Again, looking at the results upon plots 4, 5 and 6, the yield in each case where phosphoric acid entered into the ration, is about 30 bushels of hard shelled corn to the acre, but where the other two ingredients, potash and nitrogen, are united, the yield drops to 17 bushels to the acre.

Nitrogen and potash become most effective only when combined with a liberal amount of phosphoric acid. Nitrogen in the form of nitrate of soda (plots 7, 8 and 9) failed in this experiment to give as good results as in either of the other forms. The nitrate plots were upon the most gravelly portion of the field, and it is possible that this may have been due to loss by leaching.

The yield of stover on the sulphate of ammonia group of plots was greater than upon the dried blood group, though the latter produced a little more shelled corn. Both forms of nitrogen gave good results.

General Conclusions from the Summit Experiment.

1. The soil was most deficient in phosphoric acid.

2. Potash and nitrogen seemed to be about equally deficient and a combination of the two produced large additional yields only when combined with phosphoric acid.

3. Nitrogen in the form of nitrate of soda failed, in this instance, to give as good results as in the other forms, though from the fact that those plots were very gravelly, we conclude that it was possibly due to loss by leaching.

4. Nitrogen in the form of dried blood and sulphate of ammonia gave very good results and nearly equal yields, the latter producing a little less shelled corn, but relatively more stover.

DAVISVILLE, R. I.

9. Mr. A. A. Sherman's Experiment.

This soil was a medium loam. The field was in grass in 1883, and after the crop of 1884 had been harvested, a portion was plowed, planted with late sweet corn and fertilized with barn-yard manure in the hill. In 1885 a fair dressing of barn-yard manure was plowed in, one portion was planted to potatoes and the other, upon which a little of the same manure was used in the hill, served as a garden. The land was plowed in 1886 and sown with oats and red clover seed, without other seed or any manure. It was the intention to have plowed it again in 1887, but the clover and herd's grass (Phleum pratense) were so thick that it was left for a meadow. From that time until 1890, when it was plowed for this experiment, the hay crop was annually removed and no further fertilizer or manure of any kind had been applied. The depth of plowing was seven inches.

In this experiment the stover was not weighed, on account of its having been scattered by a cyclone after the husking, and in consequence the values are necessarily lower than they would otherwise have been.

The following are the results:

TABLE SHOWING THE KIND OF FERTILIZER AND YIELD PER PLOT AND PER ACRE.

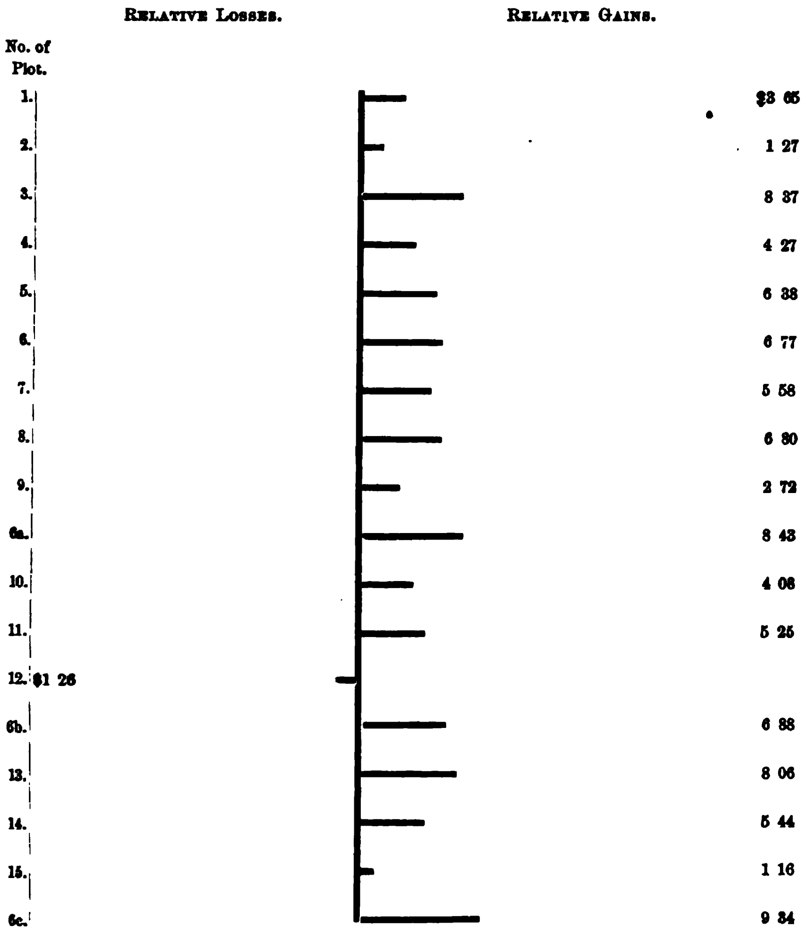
No. of Plot.	KIND OF FERTILIZER.	Total yield per Plot.			Total yield per Acre.		
		Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing................................	104.0	56.0	Scattered by a cyclone and could not be weighed.	29.71	16.00	Scattered by a cyclone and could not be weighed.
1.	Nitrate of Soda.	164.5	40.0		47.00	11.43	
2.	Dissolved Bone Black, (14 per cent. soluble acid)......................	161.0	33.5		46.00	9.57	
3.	Muriate of Potash	197.0	19.0		56.28	5.43	
4.	Nitrate of Soda, Dissolved Bone Black, }	199.0	19.1		56.86	5.46	
5.	Nitrate of Soda, Muriate of Potash, }	201.5	25.0		57.57	7.14	
6.	Dissolved Bone Black, Muriate of Potash, } Mixed Minerals,	212.5	15.5		60.71	4.43	
	NITRATE OF SODA GROUP.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration, }	222.5	18.0		63.57	5.14	
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration, }	242.5	23.0		69.28	6.57	
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration, }	241.0	21.5		68.86	6.14	
6a.	Mixed Minerals as No. 6	219.5	17.0		62.71	4.86	
	SULPHATE OF AMMONIA GROUP.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration, } ..	216.0	20.0		61.71	5.71	
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration, } ..	239.0	21.5		68.28	6.14	
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration, }	226.6	22.1		64.74	6.31	
6b.	Mixed Minerals as No. 6..........	213.5	14.5		61.00	4.14	
	DRIED BLOOD GROUP.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration, }	237.5	13.5		67.86	3.86	
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration, }	242.0	16.0		69.14	4.57	
15.	Mixed Minerals as No. 6, Dried Blood, full Ration, }	238.5	19.0		68.14	5.43	
6c.	Mixed Minerals as No. 6..........	224.5	15.5		64.14	4.43	
00.	Nothing.......	151.5	35.5		43.28	10.14	

TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Stover.		Total value per acre of corn, hard and soft, over that of the "nothing" plots.	Cost of Fertilizers per Acre.	Value of the hard and soft corn pr acre over the cost of the Fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 37½c. per bush.	lbs.	Value at $7 per ton.			
1.	10.50	$7 87	—1.64	—$0 62	Scattered by a cyclone and could not be weighed.	Scattered by a cyclone and could not be weighed.	$7 25	$3 60	$3 65
2.	9.50	7 13	—3.50	—1 31			5 82	4 55	1 27
3.	19.79	14 84	—7.64	—2 87			11 97	3 60	8 37
4.	20.36	15 27	—7.61	—2 85			12 42	8 15	4 27
5.	21.07	15 80	—5.93	—2 22			13 58	7 20	6 38
6.	24.21	18 16	—8.64	—3 24			14 92	8 15	6 77
7.	27.07	20 30	—7.93	—2 97			17 33	11 75	5 58
8.	32.79	24 59	—6.50	—2 44			22 15	15 35	6 80
9.	32.36	24 27	—6.93	—2 60			21 67	18 95	2 72
6a.	26.21	19 66	—8.21	—3 08			16 58	8 15	8 43
10.	25.21	18 91	—7.36	—2 76			16 15	12 07	4 08
11.	31.79	23 84	—6.93	—2 60			21 24	15 99	5 25
12.	28.24	21 18	—6.76	—2 53			18 65	19 91	—1 26
6b.	24.50	18 38	—8.93	—3 35			15 03	8 15	6 88
13.	31.36	23 52	—9.21	—3 46			20 06	12 00	8 06
14.	32.64	24 48	—8.50	—3 19			21 29	15 85	5 44
15.	31.64	23 73	—7.64	—2 87			20 86	19 70	1 16
6c.	27.64	20 73	—8.64	—3 24			17 49	8 15	9 34

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



It appears from the results on the single ingredient plots (Nos. 1, 2 and 3) that potash was especially lacking, and the yields upon the three succeeding plots stand in harmony with such a conclusion. The profits throughout from the use of mixed minerals alone (plots 6, 6a, 6b and 6c) were good, being, in the lowest instance (plot 6), $6.77, and in the case of plot 6c, $9.34. The addition of nitrogen to this ration increased the total yield, but when furnished in an amount greater than a $\frac{2}{3}$ ration, the increased yield was in no case commensurate with the additional cost. Nitrogen in all three forms gave nearly equal results, though the sulphate of ammonia group was slightly behind each of the others in total yield and net profit.

General Conclusions from the Davisville Experiment.

1. There was a deficiency of all three of the essential elements, potash being apparently most deficient.

2. The profits from the use of mixed minerals (potash and phosphoric acid) were good in every case.

3. In general, the addition of nitrogen to the mixed mineral ration increased the total yield but not the profits, and when the amount of added nitrogen exceeded a $\frac{2}{3}$ ration, the profits were seriously reduced.

4. Nitrogen in all three forms gave fair results, though the sulphate group fell a little behind the others.

NAYATT POINT, R. I.

10. Mr. Elmer K. Watson's Experiment.

The soil was a heavy black loam, from one foot to one and a half feet in depth, with a yellow subsoil extending to a depth of from two

to three feet. The land was rather wet, due to the fact that the drains had become clogged. From twelve to fifteen years ago the field was in what would be called a good state of cultivation and was seeded to grass, a crop of which was removed each year until the past spring (1890), when it was plowed for this experiment. Mr. Watson further states that it was "what would be called worn out land," but that by drainage and manure it could be made to produce a large crop.

The following are the results of the experiment:

TABLE SHOWING THE KIND OF FERTILIZER AND YIELD PER PLOT AND PER ACRE.

No. of Plot.	Kind of Fertilizer.	Total yield per Plot. Hard Corn on the cob.	Total yield per Plot. Soft Corn on the cob.	Total yield per Plot. Stover.	Total yield per Acre. Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Total yield per Acre. Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Total yield per Acre. Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	111.9	There was so little soft corn that it was not weighed separately.	71.2	31.97	There was so little soft corn that it was not weighed separately.	1424
1.	Nitrate of Soda	136.5		96.0	39.00		1920
2.	Dissolved Bone Black (14 per cent. soluble acid)	147.8		96.5	42.23		1930
3.	Muriate of Potash	151.7		106.2	43.34		2124
4.	Nitrate of Soda, Dissolved Bone Black,	148.0		111.0	42.28		2220
5.	Nitrate of Soda, Muriate of Potash,	151.0		113.0	43.14		2260
6.	Dissolved Bone Black, Muriate of Potash, } Mixed Minerals,	146.0		112.0	41.71		2240
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, $\frac{1}{3}$ Ration,	161.9		115.7	46.26		2314
8.	Mixed Minerals as No. 6, Nitrate of Soda, $\frac{2}{3}$ Ration,	165.8		113.9	47.37		2278
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	159.5		113.5	45.57		2270
6a.	Mixed Minerals as No. 6	149.0		113.0	42.57		2260
	Sulphate of Ammonia Group.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, $\frac{1}{3}$ Ration,	151.0		114.0	43.14		2280
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, $\frac{2}{3}$ Ration,	153.0		117.0	43.71		2340
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration,	155.0		119.0	44.28		2380
6b.	Mixed Minerals as No. 6	147.0		109.0	42.00		2180
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, $\frac{1}{3}$ Ration,	150.0		113.0	42.86		2260
14.	Mixed Minerals as No. 6, Dried Blood, $\frac{2}{3}$ Ration,	153.8		114.6	43.94		2292
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	151.8		114.6	43.37		2292
6c.	Mixed Minerals as No. 6	146.0		109.0	41.71		2180
00.	Nothing	103.1		68.8	29.46		1376

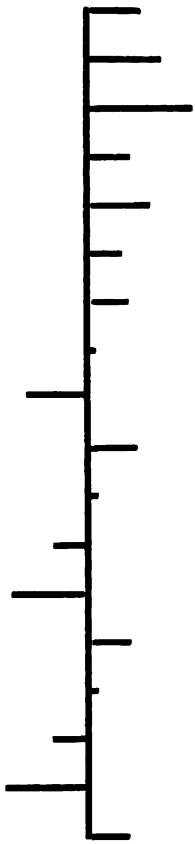
TABLE SHOWING THE IMCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on cob = 1 bush. of shelled corn.)		Stover.		Total value per acre of corn and stover over that of the "nothing" plots.	Cost of Fertilizers per Acre.	Value of the Crop per Acre over the cost of the Fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 37½c. per bush.	lbs.	Value at $7 per ton.			
1.	8.29	$6 21	There was so little soft corn that it was not weighed separately.	There was so little soft corn that it was not weighed separately.	520	$1 82	$8 03	$3 60	$4 43
2.	11.51	8 64			530	1 86	10 50	4 55	5 95
3.	12.63	9 47			720	2 53	12 00	3 60	8 40
4.	11.57	8 68			820	2 87	11 55	8 15	3 40
5.	12.43	9 32			860	3 01	12 33	7 20	5 13
6.	11.00	8 25			840	2 94	11 19	8 15	3 04
7.	15.54	11 66			914	3 20	14 86	11 75	3 11
8.	16.66	12 49			878	3 07	15 56	15 35	0 21
9.	14.86	11 14			870	3 05	14 19	18 95	—4 76
6a.	11.86	8 89			860	3 01	11 90	8 15	3 75
10.	12.43	9 32			880	3 08	12 40	12 07	0 33
11.	13.00	9 75			940	3 29	13 04	15 99	—2 95
12.	13.57	10 18			980	3 43	13 61	19 91	—6 30
6b.	11.29	8 46			780	2 73	11 19	8 15	3 04
13.	12.14	9 11			860	3 01	12 12	12 00	0 12
14.	13.23	9 91			892	3 12	13 03	15 85	—2 82
15.	12.66	9 49			892	3 12	12 61	19 70	—7 09
6c.	11.00	8 25			780	2 73	10 98	8 15	2 83

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.

No. of Plot.	Relative Losses.	Relative Gains.
1.		$4 43
2.		5 95
3.		8 40
4.		3 40
5.		5 13
6.		3 04
7.		3 11
8.		0 21
9.	$4 76	
6a.		3 75
10.		0 33
11.	2 95	
12.	6 30	
6b.		3 04
13.		0 12
14.	2 82	
15.	7 09	
6c.		2 83



From a glance at the single element plots (Nos. 1, 2 and 3), it will be seen that nitrogen alone (plot 1) is decidedly behind the phosphoric acid (plot 2) and the potash plot (No. 3).

Potash alone (plot 3) and potash with nitrogen (plot 5) gave better results than phosphoric acid alone (plot 2) or phosphoric acid and nitrogen (plot 4). The profits from the use of mixed minerals alone (plots 6, 6a, 6b and 6c) averaged about $3.00 per acre, and in two cases (plots 10 and 13), the addition of a $\frac{1}{3}$ nitrogen ration slightly raised the total yield but increased the cost of the fertilizer to such an extent as to absorb nearly all the profit which would have been derived from the mixed minerals alone. Plot 7 of the nitrate of soda group proved, however, an exception. By the addition to the mixed minerals of a $\frac{2}{3}$ nitrogen ration, the yield was raised slightly over the plots with the additional $\frac{1}{3}$ ration, but again the gain was far from commensurate with the increased cost of the fertilizer, for in the case of plot 8 the net profit was reduced to $0.12 per acre, and upon plots 11 and 14 there resulted a loss in each case of nearly $3.00 per acre. By the addition of a full nitrogen ration the loss on plot 9 amounted to $4.76, on plot 12 to $6.30 and upon plot 15 to $7.09, or, in other words, taking into account the loss in this latter case, and the possible gain by the use of the mixed minerals alone, it will be seen that it made a difference of about $10.00 per acre whether the one or the other fertilizer was used. It is doubtful, in this case, if any complete commercial fertilizer containing any considerable percentage of nitrogen would have paid for itself, and the fact is plainly brought out that the profit or loss on a crop may be controlled by a judicious use and combination of chemicals; especially is this the case when we consider the fact that nitrogen, potash and phosphoric acid can be bought thus, far more cheaply than in the form of ready mixed commercial fertilizers, and the cost of mixing, as estimated by Connecticut farmers who have practised it, rarely exceeds $1.50 per ton.

Nitrogen in the form of nitrate of soda gave, in this case, greater yields than as sulphate of ammonia or dried blood, and the net profits from its use were also greater on account of its lesser cost in the form of the nitrate.

General Conclusions from the Nayatt Point Experiment.

1. Potash, more especially, and also phosphoric acid were chiefly lacking.
2. Nitrogen increased the total yield, though the gain was not commensurate with the cost, and in every case where it was added to the mixed minerals (potash and phosphoric acid), with one exception (plot 7), it either reduced the profits or turned the otherwise profits into losses.
3. Nitrogen in the form of nitrate of soda gave greater yields than in either of the other forms, and due to its lesser cost in this form, the losses from its use were not so great as in the case of the sulphate of ammonia and dried blood.
4. The fact is strongly brought out that the profit or loss hinges largely upon knowing the wants of the individual soil and in furnishing just what the special case demands.

11. Jamestown, R. I., (South End) Experiment.

Owing to a misunderstanding, the results were not reported in the intended form; pumpkins were also planted with the corn, which, together with other unavoidable circumstances, have prevented us from publishing the results.

Some Notes relative to the Cost of Labor in Growing the Corn upon the Experimental Acres.

It must be borne in mind that the fertilizer had to be applied with unusual care, and that the cost of harrowing, cultivating and hoeing was somewhat increased, from the fact that the plots were

only worked lengthwise. The cost of harvesting was also greater on account of weighing the yields.

The following is the cost of production as given by Messrs. Capwell & Tillinghast, of Summit, R. I. In this case, the entire product of corn and stover was weighed.

Plowing	$3 00
Harrowing and rolling	1 00
Applying fertilizer and harrowing	2 00
Planting, including furrowing, etc	3 00
Cultivating, hoeing and pulling weeds	3 75
Cutting	1 25
Drawing, husking and weighing	4 00
	$18 00

Mr. Tillinghast adds: "These results are approximate to the time actually employed, and are considerably more than usual, as we took every precaution to have the results accurate."

Cost of production as estimated by Mr. E. F. Crowninshield, of Abbott Run, R. I.:

Plowing	$2 00
Harrowing	40
Marking	30
Sowing fertilizer	1 00
Harrowing in fertilizer	35
Planting	1 00
Hoeing and cultivating	4 00
Stooking corn	2 50
Husking corn	4 32
	$15 87

Cost of production as estimated by Mr. J. B. Vaughn, of Nooseneck, R. I.:

14

Plowing	$3 00
Harrowing and sowing fertilizer	4 00
Planting	1 50
Harrowing the corn	75
Hoeing	3 00
Cutting up corn	1 50
Husking	2 00
	$15 75

General Comments on the Experiments.

No claim is made that these experiments are strictly scientific, i. e., strictly exact; in fact, *if every precaution is taken*, there are so many uncontrollable and modifying factors which come into play that such experiments cannot give absolute results. The land for these experiments was not prepared and selected with that care which can be bestowed by an Experiment Station, where the means at disposal allow the subordination of everything else to exactness.

It was the design of these co-operative experiments that they should be made as exact as possible, and still be kept within the range of the practical farmer. That valuable data have thus been gathered in other States, as well as in our own experiments, there remains no room for doubt.

Since a summary of the results of each experiment is given, in connection with the previous consideration of the same, we append here simply a brief summary of the

GENERAL RESULTS OF THE EXPERIMENTS.

The experiments show that there existed a wide variation in the fertility of the soils, and that cases of one-sided exhaustion were not of uncommon occurrence.

In four cases, at least, potash appeared most deficient, and it is interesting to observe that the two most marked cases of a deficiency of phosphoric acid were upon old pastures.

In one or two instances, the application of nitrogen, even in small quantities, resulted in little or no profit, and in general, its application in large quantities, though it in some measure increased the crop, resulted in financial loss. Nitrogen proved most profitable upon soils with little sod and humus, i. e., light, sandy or gravelly loams.

Taking all the experiments into consideration, nitrogen in the form of nitrate of soda was more certain to give fair returns than in either of the other forms. Its lesser cost is also an additional argument in its favor.

The sulphate of ammonia gave, in one or two instances, better returns than nitrate of soda, though in two cases, at least, the period of growth was prolonged by its use, which may, perhaps, have been due to delayed nitrification. In one instance, the sulphate nitrogen appears not only not to have become available to the plant, but to have had a decidedly injurious effect, for it more than neutralized the otherwise good effect of the potash and phosphoric acid with which it was applied. The greater the application of the sulphate, the more disastrous were the results.

On the whole, nitrogen in the form of dried blood proved inferior to both of the other forms.

I desire, in this place, to thank the gentlemen who co-operated in these experiments, for their earnest efforts to make them a success.

H. J. W.

HORTICULTURAL DIVISION.

L. F. KINNEY.

The facilities for the work of this division have been materially increased during the past year. Laboratory and office accommodations have been provided in the Experiment Station building. These are supplied with a reference library, photographic apparatus, microscopes, etc. A collection of dried specimens of the native and introduced grasses of the State has been prepared, and numerous additions have been made to the collection of vegetable and noxious weed seeds. An apartment in one of the farm buildings has been fitted up for and well furnished with, garden implements, grafting tools, and apparatus for applying insecticides and fungicides. Several acres of sward land have been cleared of stone and brought under cultivation with a crop of corn, potatoes, turnips and other vegetables. About four hundred and fifty varieties of the larger and small fruits have been planted out on the Station grounds, and during the summer a descriptive catalogue of these was issued in Bulletin No. 7. This report contains the details of the following experiments, viz:

Planting equal weights of seed potato, per row, the hills 9, 18 and 36 inches apart.

Planting equal weights of seed potato, per hill, the hills 9, 18 and 36 inches apart.

Comparative yields of a large list of varieties of potatoes.

The Bordeaux Mixture as a preventive of the potato blight and rot.

The ridge and flat systems of cultivation for parsnips.

Bush beans and special fertilizers.

Lawn grasses, and new varieties of fruits and vegetables.

EXPERIMENT WITH POTATOES. NO. 1.

Equal Weights of Seed Potato Planted per Row, the Hills 9, 18 and 36 inches apart.

This experiment was, mainly, a repetition of a similar trial made at the Station last year, but the results of which were not entirely satisfactory, due to the unfavorable season for the potato crop. A portion of the field used the preceding year, was again set apart for this trial, it having received during the winter a top-dressing of stable manure at the rate of eight cords per acre. A special fertilizer was applied in the furrows just before planting, at the rate of 1500 pounds per acre. This was composed of Sulphate of Potash, Dissolved Bone Black, Nitrate of Soda and Tankage, in the following proportions by weight, viz: $\frac{1}{3}$ Sulphate of Potash, $\frac{1}{3}$ Dissolved Bone Black, $\frac{1}{6}$ Nitrate of Soda and $\frac{1}{6}$ Tankage.

May 10th the plot was marked out 96 feet long and 54 feet wide; it was then divided into three equal sections, viz: A. B. and C., each 96 feet long and $16\frac{2}{3}$ feet wide, leaving two open spaces, two feet wide between the sections, (see illustration, Fig. I.) Thirty rows of potatoes were then planted, each fifty feet long and three feet apart; or one row each of thirty varieties, varying in their seasons of maturity from *early* to *late*. As may be seen in Fig. I., each section contained a row $16\frac{2}{3}$ feet long of each variety. The seed potatoes planted in each section were in all cases from the same source, and the treatment and culture through the entire plat

were as near alike as possible. The weight of the tubers planted in each section was the same, that is, one-half pound of each variety.

In Section A., in each case, the one-half pound of seed potatoes was cut (in the field) into small—usually single eye—pieces which were planted 9 inches apart. In Section B., in each case, the one-half pound of seed potatoes was cut (in the field) into medium—usually two eye pieces—which were planted 18 inches apart. In Section C., in each case, the one-half pound of seed potatoes was planted without cutting, or so far as it was possible, and have the hills 36 inches apart.

Table I. contains the yield of each variety in each section, of both large and small potatoes, calculated to bushels and hundredths of a bushel per acre; also the average total yield of each variety.

Table II. contains the actual number of both large and small tubers formed in each section, and by each variety, with the average individual weight of these, together with the *average total* number of tubers formed by each variety.

See Plate I.

TABLE I.

Showing the results obtained by planting single-eye pieces, two-eye pieces and whole Potatoes; the yield calculated to bushels and hundredths of a bushel per acre.

VARIETY.	SECTION A. Single-eye pieces, 9 inches apart.		SECTION B. Two-eye pieces, 18 in. apart.		SECTION C. Whole Potatoes, 36 in. apart.		Average total yield.
	Merchantable.	Small.	Merchantable.	Small.	Merchantable.	Small.	
	bush.	bush.	bush.	bush.	bush.	bush.	bush.
American Giant	278.78	27.58	190.21	43.56	174.24	50.82	237.87
Andrew's White Rose	331.38	117.28	237.96	122.20	285.88	78.74	424.54
American Magnum Bonum	288.92	28.78	262.58	31.45	240.80	37.98	290.84
Alexander's Prolific	347.19	17.42	435.60	43.56	348.48	43 56	412.27
Bliss' Triumph	145.20	118.06	186.02	75.50	206.18	36.10	255.68
Buffalo Beauty	270.07	43.56	319.44	60.98	319.44	53.72	355.74
Bonanza	364.90	68.24	377.52	79.86	348.48	58.08	432.54
Brook's Seedling	312.18	43.36	290.40	53.72	254.10	116.16	356.64
Belle	209.08	43.56	290.40	14.52	261.32	87.12	302.00
Burpee's Superior	246.84	108.90	261.36	53.72	275.88	36.20	327.63
Brownell's No. 31	290.40	58.00	188.76	101.64	174.24	72.60	295.21
Banana	246.84	58.08	290.40	58 08	217.80	79.86	317.02
Brownell's Success	126.16	65.34	145.20	50.82	137.94	65.34	193.60
Brownell's No. 55	261.36	72.60	203.28	79 86	203.28	126.16	315.51
Baker's Imperial	159.72	58.08	290.40	36.30	275.88	65.34	295.24
Borough's Garfield	254.10	48.56	290.40	58.08	290 40	50.82	329.12
Crandall's Beauty	65.34	43.56	101.64	94.38	159.72	89.12	183.92
Champlain	290.40	14.52	392.04	43.56	275.88	72.60	363.00
Colvin's Superb	246.84	72.60	268.62	21.78	283.14	21.70	304.89
Clark's No. 1	275.88	14.52	275.88	36.30	290.40	29 04	307.34
Climax	246.84	65.34	261.36	72.60	319.44	72.60	346.06
Crown Jewel.	275.88	72.60	246.84	119.78	275.88	87.12	359.37
Crane's June Eating.	196 02	50.82	246.84	50.82	290.40	58.08	297.66
Connecticut	174.24	58 08	261.36	58.08	290.40	29.04	290.40
Churchill's Seedling	174.24	72.60	232.32	43.56	232.32	36.30	263.78
Cayuga	232.32	36 30	283.14	36.30	341.22	21.78	317.02
Cherry Blow	261.36	58.08	392.04	43.56	290.40	58.08	367.84
Chessman's Seedling	319.44	14.52	333.96	29.04	406.56	7.26	370.26
Chicago Market	246.84	72.60	261.36	58.08	217.80	58.08	304.92
Chas. Downing	245.74	50.82	377.52	81.31	304.92	65.34	358.72
Cambridge Prolific	3?3.96	58.08	406.56	65.34	333.96	50.82	416.57
Centennial	225.06	65.44	232.32	29.04	275.88	43.56	390.43
Sum	7943.52	1792.88	8983.73	1847 38	8708.66	1869.02	10425.63
Average	248.24	56.03	280.74	57.73	271.99	58.41	325.80

Table II.

Showing the number of both Merchantable and Small Potatoes formed in each 16½ ft. of row, and their average individual weight in ounces and tenths of an ounce.

Variety.	Section A. Single-eye pieces, 9 in. apart.				Section B. Two-eye pieces, 18 in. apart.				Section C. Whole Potatoes, 36 in. apart.				Average total No. of Tubers formed by each variety in Section.
	Merchantable.		Small.		Merchantable.		Small.		Merchantable.		Small.		
	No. of Tubers.	Average Weight of Tubers.	No.	Average Weight.	No.	Average Weight.	No.	Average Weight.	No.	Average Weight.	No.	Average Weight.	
		oz.		oz.		oz.		oz.		oz.		oz.	
American Giant	63	5.0	36	1.3	37	5.6	45	0.9	44	4.3	50	1.1	91.6
Andrew's White Rose	84	4.2	84	1.3	65	5.7	122	1.0	60	5.3	86	0.8	83.5
American Magnum Bonum	41	7.7	16	1.5	58	5.2	11	1.9	45	5 5	12	1.5	61.0
Alexander's Prolific	71	5.6	22	1.0	88	5.5	39	1.1	63	6.1	29	1.5	103.3
Bliss' Triumph	36	4.4	63	1.7	50	4.3	48	1.7	47	4.1	24	1.6	96.0
Buffalo Beauty	52	5.8	54	0.9	62	5.8	51	1.3	57	6.2	40	1.5	105.3
Bonanza	55	7.5	51	1.5	65	6.4	54	1.6	79	4.9	61	1.0	121.6
Brook's Seedling	60	5.7	38	1.1	47	6.8	35	1.7	48	5.8	75	1.7	101.0
Belle	42	5.3	17	1.8	38	8.4	15	1.0	27	10.6	8	0.7	49.0
Burpee's Superior	53	5.1	46	1.9	76	3.8	37	1.6	47	6.5	15	1.7	91.3
Brownell's No. 31	84	3.8	30	1.8	68	3.5	70	1.6	83	2.3	51	1.6	128.7
Banana	53	5 1	45	1.4	64	5.0	50	1.3	47	5.1	69	1.3	109.3
Brownell's Success	27	4 7	40	1.8	50	3.2	44	1.3	45	3.4	62	1.0	89.3
Brownell's No. 55	77	3.7	65	1.2	67	3.3	77	1.0	64	3.5	79	1.6	143.0
Baker's Imperial	45	3.9	43	1.5	62	5.1	15	1.9	60	5.0	74	0.9	99.7
Borough's Garfield	56	5.0	41	1.2	76	4.2	53	1.2	81	3.9	31	1.8	112.7
Crandall's Beauty	29	2.5	60	0.8	40	2.8	92	1.1	48	3.7	84	1.1	117.7
Champlain	65	4.9	14	1.1	115	3.7	43	1.1	79	3.8	63	1.3	126.3
Colvin's Superb	59	4.6	60	1.3	47	6.3	20	1.2	75	4.1	20	1.2	93.6
Clark's No. 1	60	5.1	25	0.6	67	4.6	31	1.3	50	6.4	32	1.0	88.3
Climax	70	3.9	46	1.6	69	4.1	54	1.5	99	3.5	65	1.2	134.3
Crown Jewel	74	4.1	83	0.9	70	3.9	76	1.8	78	3.9	69	1.4	150.0
Crane's June Eating	50	4.3	37	1.4	66	4.1	19	1.9	64	5.0	26	1.8	87.3
Connecticut	60	3.2	71	0.9	74	3.9	47	1.4	67	4.8	43	0.7	120.6
Churchill's Seedling	59	3.4	54	1.5	74	3.4	43	1.1	57	4.4	33	1.2	106.6
Cayuga	70	3.6	23	1.7	67	4.7	9	1.9	83	4.5	20	1.8	90.6
Cherry Blow	82	3.5	45	1.4	87	5.0	36	1.3	85	3.8	62	1.0	132.3
Chessman's Seedling	70	5.0	15	1.0	68	5 4	25	1.2	70	6.4	12	0.6	86.7
Chicago Market	55	4 9	52	1.5	56	5.1	41	1.6	55	4.4	53	1.2	104.0
Chas. Downing	100	3.9	60	0.9	95	4.4	125	0.8	71	4.7	39	1.7	163.3
Cambridge Prolific	75	4.9	47	1.4	68	6.6	55	1.3	58	6.3	83	1.7	112.0
Centennial	76	3.3	70	1.0	63	4.0	50	0.6	75	4.0	78	0.6	137.3
Sum	1953	147.6	1453	41.9	2099	153.8	1532	43.2	2011	156.2	1498	41.1	3437.2
Average	61.0	4.6 oz.	45.4	1.3 oz.	65.5	4.8 oz.	47.9	1.4 oz.	62.8	4.9 oz.	46 8	1.3 oz.	107.4

SUMMARY OF TABLES I. AND II.

	Section A.			Section B.			Section C.		
	Single-eye pieces, 9 in. apart.			Two-eye pieces, 18 in. apart.			Medium sized whole Potatoes, 36 in. apart.		
	Average Number of Tubers formed by each variety.	Average weight of the individual Tubers.	Average yield calculated to bushels and hundredths of a bushel per acre.	Average Number of Tubers formed by each variety.	Average weight of the individual Tubers.	Average yield calculated to bushels and hundredths of a bushel per acre.	Average Number of Tubers formed by each variety.	Average weight of the individual Tubers.	Average yield calculated to bushels and hundredths of a bushel per acre.
		oz.	bush.		oz.	bush.		oz.	bush.
Merchantable.....	61.0	4.6	248.24	65.5	4.9	279.18	62.8	4.9	268.83
Small............	45.4	1.3	56.34	47.9	1.4	57.73	46.8	1.3	58.04
Total....	106.4	3.2	304.58	113.4	3.4	336.91	109.6	3.3	326.87

Enumeration of Results.

First. The average number of tubers formed in Section A., was 6.1 per cent. less than the average number formed in Section B. and 3.0 per cent. less than the average number formed in Section C.

Second. The per cent. of merchantable potatoes was largest in Section B. and least in Section A., yet it varied but slightly in the three sections.

Third. The average weight of the individual tubers was most in Section B. and least in Section A.

Fourth. The average yield was largest in Section B. and larger in Section C. than in Section A.

See Plate II.

EXPERIMENT WITH POTATOES. NO. 2.

Equal Weights of Seed Potato Planted per Hill, the Hills being 9, 18 and 36 inches apart in the Row.

This experiment was conducted under the same conditions as the preceding one, and was planned to determine the comparative products of varying amounts of seed potato when planted at the same and different distances apart in the row.

The three varieties used in the trial were the Bliss' Triumph, Thorburn and Weld's Early, and the product in each case given in the tables is that of 25 ft. of row—the rows being three feet apart.

The tables contain the yield of each variety in pounds and hundredths of a pound; the number of tubers formed in each case; the per cent. of the tubers (by number) that were merchantable, that is, that weighed two ounces or more, and the average weight of the individual tubers in all of the cases. An examination of the tables will show that the average yield, where the whole potatoes were planted, was more than double that where the single-eye pieces were planted, both nine and eighteen inches apart, and nearly double the amount where the hills were thirty-six inches apart. Again, the average yield where whole potatoes were planted nine inches apart, was more than one-fourth larger than where two-eye pieces were planted, and at eighteen and thirty-six inches, the yield was more than one-third larger where whole potatoes were planted than where two-eye pieces were used for seed. The average yield was also largest where the hills were nine inches apart, and it decreased as the distance between the hills increased.

The average number of tubers formed was largest where the most seed potato was planted—that is, where whole potatoes were planted nine inches apart—and the number gradually decreased with the size of the pieces planted and the increase of the distance between the hills.

The decrease in the per cent. of merchantable tubers usually followed a rule just the reverse of the decrease in the yield and the number of tubers formed; that is, the per cent. of merchantable potatoes was generally largest where the least seed was planted — the highest average per cent. being obtained where the hills were thirty-six inches apart.

The individual potatoes were usually of better average size where the single and two-eye pieces were planted than where whole potatoes were used, and the best average individual weight occurred where the hills were eighteen inches apart. The details of the experiment are recorded in the following tables.

TABLE I.

Hills 9 inches apart in the rows; the rows 25 ft. long and 3 ft. apart.

	Single Eyes.	Two Eyes.	Medium Whole Potatoes.	Large Whole Potatoes.	Average yield of the individual varieties.	Average yield of the three varieties.
Bliss' Triumph	11.25 lbs.	12.50 lbs.	21.70 lbs.	....	15.15 lbs.	....
Thorburn	11.25 "	24.40 "	29.00 "	36.25 lbs.	21.57 "	....
Weld's Early	18.30 "	29.25 "	32.50 "	....	26.68 "	....
Average	13.60 lbs.	22.05 lbs.	27.73 lbs.	....	21.13 lbs.	21.13 lbs.

Number of Tubers formed.

	Single Eyes.	Two Eyes.	Medium Whole Potatoes.	Large Whole Potatoes.	Average.	Average of the three varieties.
Bliss' Triumph	67.	79.	156.	....	106.	....
Thorburn	63.	172.	230.	232.	155.3	....
Weld's Early	84.	156.	237.	....	159.0	....
Average	71.3	136.0	207.6	....	138.3	138.3

Per cent. of the Potatoes Merchantable and the Average Weight of the Individual Tubers.

	Single Eyes.		Two Eyes.		Medium Whole Potatoes.		Large Whole Potatoes.		Average.		Average of the three varieties.	
	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individ. Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.
Bliss' Triumph	33.3 pr ct.	2.6 oz.	32.8 pr ct.	2.5 oz.	27.5 pr ct.	2.2 oz.	....	....	31.2 pr ct.	2.4 oz.	....	....
Thorburn	36.5 "	2.8 "	39.3 "	2.3 "	28.0 "	2.0 "	43.5 pr ct.	2.5 oz.	34.6 "	2.4 "	....	....
Weld's Early	64.3 "	3 5 "	38.2 "	3.0 "	16.4 "	2.2 "	....	....	39.7 "	2.9 "	....	....
Average	44.7 pr ct.	2.9 oz.	36.8 pr ct.	2.6 oz.	24.0 pr ct.	2.1 oz.	....	....	35.2 pr ct.	2.6 oz.	35.2 pr ct.	2.6 oz.

TABLE II.

Hills 18 inches apart in the rows; the rows 25 ft. long and 3 ft. apart.

	Single Eyes.	Two Eyes.	Medium Whole Potatoes.	Large Whole Potatoes.	Average yield of the individual varieties.	Average yield of the three varieties.
Bliss' Triumph....	6.9 lbs.	11.9 lbs.	15.0 lbs.	....	11.8 lbs.	....
Thorburn...............	11.2 "	16.2 "	25.6 "	33.1 lbs.	17.7 "	....
Weld's Early....	14.4 "	29.4 "	37.5 "	....	27.1 "	....
Average.	10.8 "	19.2 lbs.	26.0 lbs.	....	18.7 lbs.	18.7 lbs.

Number of Tubers formed.

	Single Eyes.	Two Eyes.	Medium Whole Potatoes.	Large Whole Potatoes.	Average.	Average of the three varieties.
Bliss' Triumph...............	35.	80.	98.	....	71.0	....
Thorburn..................	43.	73.	150.	185.	88.7	....
Weld's Early....	55.	87.	200.	....	114 0	....
Average.....	44.3	80.0	149.3	....	91.2	91.2

Per cent. of the Potatoes Merchantable and the Average Weight of the Individual Tubers.

	Single Eyes.		Two Eyes.		Medium Whole Potatoes.		Large Whole Potatoes.		Average.		Average of the three varieties.	
	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.
Bliss' Triumph..............	65.7 pr ct.	3.1 oz.	31.5 pr ct.	2.4 oz.	27.5 pr ct.	2.3 oz.	....	....	41.6 pr ct.	2.6 oz.	....	....
Thorburn........	55.8 "	4.4 "	53.4 "	3.5 "	32.0 "	2.7 "	42.6 pr ct.	2.8 oz.	47.1 "	3.5 "	....	....
Weld's Early....	72.7 "	4.2 "	64.3 "	5.4 "	48.5 "	3.0 "	....	....	61.5 "	4.2 "	....	....
Average................	64.7 pr ct.	3.9 oz.	49.7 pr ct.	3.8 oz.	35.7 pr ct.	2.7 oz.	....	....	50.1 pr ct.	3.4 oz.	50.1 pr ct.	3.4 oz.

TABLE III.

Hills 3 feet apart in the rows; the rows 25 ft. long and 3 ft. apart.

	Single Eyes.	Two Eyes.	Medium Whole Potatoes.	Large Whole Potatoes.	Average yield of the individual varieties.	Average yield of the three varieties.
Bliss' Triumph	5.0 lbs.	6.3 lbs.	9.4 lbs.	....	6.9 lbs.	... .
Thorburn	9.4 "	15.0 "	25 0 "	26.9 lbs.	16.5 "	....
Weld's Early	13.8 "	15.0 "	21.9 "	....	16.9 "	....
Average	9.4 lbs.	12.1 lbs.	18.4 lbs.	....	13.4 lbs.	13.4 lbs.

Number of Tubers formed.

	Single Eyes.	Two Eyes.	Medium Whole Potatoes.	Large Whole Potatoes.	Average.	Average of the three varieties.
Bliss' Triumph	37.	32.	51.	....	40.0	....
Thorburn	57.	70.	128.	136.	85.0	....
Weld's Early	95.	57.	100.	....	84.0	....
Average	63.	53.	93.	... .	69.0	69.0

Per cent. of the Potatoes Merchantable and the Average Weight of the Individual Tubers.

	Single Eyes.		Two Eyes.		Medium Whole Potatoes.		Large Whole Potatoes.		Average.		Average of the three varieties.	
	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual Tubers.	Per Cent. Merchantable.	Average weight of the individual varieties.
Bliss' Triumph	59.5 pr ct.	2.2 oz.	62.2 pr ct.	3.1 oz.	49.0 pr ct.	2.9 oz.	... .	... .	46.9 pr ct.	2.7 oz.	....	....
Thorburn	52.6 "	2.6 "	50.0 "	3.4 "	50.8 "	3.1 "	55.1 pr ct.	3.2 oz.	51.1 "	3.0 "	....	....
Weld's Early	42.1 "	2.3 "	79.3 "	4.2 "	55.0 "	3.5 "	....	....	58.8 "	3.3 "	....	....
Average	51.4 pr ct.	2.4 oz.	63.8 pr ct.	3.6 oz.	51.6 pr ct.	3.2 oz.	....	....	55 6 pr ct.	3.0 oz.	55.6 pr ct.	3.0 oz.

Table IV.

Summary of the Averages taken from the preceding three Tables.

Hills nine inches apart, rows 25 ft. long.

	Average yield in pounds and tenths of a pound.	Average number of Tubers formed.	Average per cent. merchantable, (by number.)	Average weight of the individual Tubers.	Average yield per row where the hills were 9 in. apart.	Average number of Tubers formed per row where the hills were 9 in. apart.	Average per cent. of the Potatoes merchantable where the hills were 9 in. apart.	Average weight of the individual Tubers where the hills were 9 in. apart.
Single Eyes.............	13.6 lbs.	71.3	44.7 per cent.	2.9 oz.				
Two Eyes...............	22.1 "	136.0	36.8 "	2.6 "				
Whole Potatoes.........	27.7 "	207.6	24.0 "	2.1 "	21.1 lbs.	183.3	35.2 per cent.	2.5 oz.

Hills eighteen inches apart, rows 25 ft. long.

	Average yield in pounds and tenths of a pound.	Average number of Tubers formed.	Average per cent. merchantable, (by number.)	Average weight of the individual Tubers.	Average yield per row where the hills were 18 in. apart.	Average number of Tubers formed per row where the hills were 18 in. apart.	Average per cent. of the Potatoes merchantable where the hills were 18 in. apart.	Average weight of the individual Tubers where the hills were 18 in. apart.
Single Eyes...	10.8 lbs.	44.3	64 7 per cent.	3.9 oz.				
Two Eyes...............	19.2 "	80.0	49.7 "	3.8 "				
Whole Potatoes.........	26.0 "	149.3	35.7 "	2.7 "	18.7 lbs.	91.2	50.0 per cent.	3.5 oz.

Hills thirty-six inches apart, rows 25 ft. long.

	Average yield in pounds and tenths of a pound.	Average number of Tubers formed.	Average per cent. merchantable, (by number.)	Average weight of the individual Tubers.	Average yield per row where the hills were 36 in. apart.	Average number of Tubers formed per row where the hills were 36 in. apart.	Average per cent. of the Potatoes merchantable where the hills were 36 in. apart.	Average weight of the individual Tubers where the hills were 36 in. apart.
Single Eyes....	9.4 lbs.	63.0	51.4 per cent.	2 4 oz.				
Two Eyes......	12.1 "	53.0	63.8 "	3.6 "				
Whole Potatoes....	18.4 "	93.0	51.6 "	3.2 "	13.3 lbs.	69.7	55.6 per cent.	3.1 oz.

Summary of Results as shown by the foregoing Table.

First. The yield of potatoes was in proportion to the amount of seed potato planted; that is, in every case the product from the whole potatoes was largest, and the product from the single eye pieces (with a single exception) least.

Second. The yield was in proportion to the distance between the hills; that is, the average product was largest where the hills were nine inches apart, and least where the hills were thirty-six inches apart.

Third. The average number of tubers formed was largest where whole potatoes were planted and (with a single exception) it was least where single eye pieces were planted.

Fourth. The number of tubers formed was in proportion to the distance between the hills; that is, the average number was largest where the hills were nine inches apart, and least where the hills were thirty-six inches apart.

Fifth. The average weight of the individual tubers grown from single eye pieces, was slightly more than the average weight of the tubers grown from two eye pieces, and decidedly more than the average weight of the tubers grown from whole potatoes.

Sixth. The average weight of the individual tubers was largest where the hills were eighteen inches apart, and least where the hills were nine inches apart.

Seventh. The per cent. of merchantable potatoes varied in proportion to the amount of seed potato planted; that is, the largest average per cent. of merchantable potatoes (by number) was produced by single eye pieces (with a single exception), and the smallest average per cent. of merchantable potatoes (by number) was produced where whole potatoes were planted.

Eighth. The per cent. of merchantable potatoes varied in proportion to the distance between the hills; that is, the largest average per cent. of merchantable tubers was grown where the hills were thirty-six inches apart, and least where the hills were nine inches apart.

Conclusions drawn from Experiments Nos. 1 and 2 with Potatoes.

I. When equal amounts of seed potatoes are planted per row, better results are obtained when the tubers are cut into medium sized (two eye) pieces and planted 18 inches apart, than when cut into fine (one eye) pieces and planted 9 inches apart, or than when the tubers are planted whole, the hills being 36 inches apart. (Experiment No. 1.)

II. The hills being the same distance apart, the yield is larger when whole potatoes are planted then when the tubers are cut into medium sized or fine pieces. (Experiment No. 2.)

III. When the potatoes or the sections of potatoes planted are of equal size, the yield is larger when the hills are 9 inches apart than when they are 18 or 36 inches apart, but the yield in the first case may not be sufficiently greater than in the other cases to cover the extra expense of the seed potatoes. (Experiment No. 2.)

LIST OF THE VARIETIES OF POTATOES GROWN AT THE EXPERIMENT STATION LAST YEAR, WITH NOTES AND BRIEF DESCRIPTIONS OF EACH.

The varieties marked with the asterisk (*) are considered the most desirable for this State.

NAME.	DESCRIPTION OF TUBERS.	Season of Maturity.
Alexander's Prolific.	Size medium, oblong; skin white, slightly netted, eyes not deep. Quality medium to good, productive. Introduced by J. C. Vaughan, Illinois, 1885.	Medium.
American Giant.	Size medium to large, rather long, slightly flattened; skin white, eyes shallow, surface smooth. Quality medium to good, moderately productive. Originated in New York.	Medium to late.
Angell's No. 27.	Size medium, oblong; skin white, netted; eyes nearly circular, not deep. Quality good, moderately productive. (Received from Wisconsin for trial.)	Medium.
Arctic.	Size medium, round, oblong; skin white, eyes shallow. Quality medium, moderately productive.	Early to medium.
Badger State.	Size medium, oblong, slightly flattened; skin white, eyes shallow. Quality medium, moderately productive. Originated by Mr. Heubner of Wisconsin. Of recent introduction.	Medium to late.
Baker's Imperial.	Size medium, half-long, flattened; skin light pink or red, eyes not deep. Quality medium, moderately productive.	Medium.
Banana.	Size medium, oblong, slightly flattened, and tapering towards the ends; skin creamy white, flesh often shaded with pink, eyes noticeably composite, of medium depth. Quality medium to good. Moderately productive.	Medium.
Belle.	Size medium to large, oblong, slightly flattened or often round; skin light red, eyes of medium depth. Quality medium to good. Moderately productive.	Medium to late.
Ben. Harrison.	Size medium or below, kidney-form or often oval or nearly spherical; skin white, russety, eyes shallow. Quality medium to good. Moderately productive.	Medium to late.

VARIETIES OF POTATOES GROWN, &c.—Continued.

NAME.	DESCRIPTION OF TUBERS.	Season of Maturity.
Bill Nye.	Size medium, rather long; skin white, smooth; eyes not deep. Quality medium, moderately productive.	Medium to late.
*Bliss' Triumph.	Size medium or below, nearly spherical in outline; skin red, eyes deep. Quality medium to good. Moderately productive.	Early.
Bliss' Diamond.	Size small, nearly spherical; skin dark, russety, thick and distinctly tesselated with irregular mostly four-sided checkers, eyes few and slightly indented. Quality medium to poor. Not productive.	Early to Medium.
Boley's Northern Spy.	Size medium, oblong, slightly flattened, often tapering towards the seed end; skin light red, eyes shallow. Quality good. Moderately productive.	Medium.
Bonanza.	Size medium, oblong, often tapering towards the seed end; skin light red, eyes nearly even with the surface, distinctly composite. Quality medium to good. Productive.	Medium.
Boston Market.	Size medium, rather short; skin pink or light red, eyes of medium depth. Quality medium. Moderately productive.	Early to medium.
Brook's Seedling.	Size medium to large, short, slightly angular in outline; skin flesh color, eyes deep. Quality medium to poor. Productive.	Late.
Brown Beauty.	Size medium, oblong; skin light purple, with patches or indistinct zones of russet brown, eyes of medium depth. Quality medium. Not productive.	Early to medium.
Brownell's No. 31.	Size medium, oblong, slightly flattened; skin white or shaded with light red, surface very smooth, eyes shallow. Quality medium. Moderately productive.	Medium.
Brownell's No. 55.	Size medium or below, oval, flattened; skin white, coarsely netted, surface smooth, eyes shallow. Quality medium. Moderately productive.	Medium.
Brownell's Success.	Size medium or below, short, flattened; skin white, eyes shallow. Quality medium. Moderately productive.	Medium.

VARIETIES OF POTATOES GROWN, &c.—Continued.

NAME.	DESCRIPTION OF TUBERS.	Season of Maturity.
*Brownell's Winner.	Size medium or above, oblong; skin creamy-white, shaded with light red, eyes of medium depth. Quality medium to good. Productive. A very promising new variety.	Early.
Buffalo Beauty.	Size medium, oblong; skin white, coarsely netted, eyes shallow. Quality medium. Productive.	Medium to late.
Burbank's Seedling.	Size medium or above; skin white, often netted, eyes shallow. Quality medium to good. Productive.	Medium to late.
Burpee's Extra Early.	Size medium, oblong, slightly flattened; skin light red, russety, eyes few and shallow, surface smooth. Quality good to very good. Productive. Introduced in 1889.	Early.
Burpee's Superior.	Size medium, oblong, often tapering towards the ends; skin white, slightly netted, eyes shallow. Quality medium to good. Productive. Originated in New York State in 1884.	Medium to late.
Canada Prince Albert.	Size medium, oblong, or often tapering towards the seed end; skin light red, eyes shallow. Quality medium. Productive.	Medium.
Cayuga.	Size medium, oblong, flattened; skin white, netted, eyes few, shallow. Quality medium to good. Productive.	Medium.
Cambridge Prolific.	Size medium, oblong, often flattened; skin white, netted. Quality medium. Very prolific.	Medium.
Champion of America.	Size medium, rather short; skin white, shaded with light red, eyes of medium depth, surface slightly uneven. Quality medium. Moderately productive.	Medium.
*Champlain.	Size medium, oval; skin light red, coarsely netted, eyes shallow, surface smooth. Quality very good. Productive.	Medium.
*Chas. Downing.	Size medium or above, roundish, usually flattened; skin white, russety, eyes shallow. Quality medium to good. Productive.	Early to medium.
Cherry Blow.	Size medium, oval, flattened; skin light red, shaded with carmine, eyes of medium depth, surface slightly uneven. Quality medium. Productive.	Early to medium.

VARIETIES OF POTATOES GROWN, &c.—Continued.

Name.	Description of Tubers.	Season of Maturity.
Chessman's Seedling.	Size medium, oblong, flattened; skin very white, netted; eyes shallow. Quality rather poor. Productive.	Early to medium.
Chicago Market.	Size medium, oval, or often truncated at the ends; skin light red, netted, eyes deep. Quality good. Productive.	Early to medium.
Chicago Sun.	Size medium, oblong, often tapering towards the seed end; skin white, russety, eyes shallow. Quality medium. Moderately productive.	Medium.
Churchill's Seedling.	Size medium, rather short, often flattened; skin white, russety, eyes of medium depth. Quality medium. Moderately productive.	Medium to late.
Clark's No. 1.	Size medium, of the Early Rose type; skin light red, eyes shallow. Quality medium to good. Moderately productive.	Early.
Climax.	Size medium, oval, often flattened; skin white, eyes shallow, surface smooth. Quality good. Productive.	Medium to late.
Colvin's Superb.	Size medium, rather long; skin white, slightly russety, eyes shallow. Quality medium to good. Moderately productive.	Medium.
Connecticut.	Size medium, oval, often flattened; skin light red, eyes shallow. Quality medium. Moderately productive.	Early to medium.
Country's Pride.	Size medium, oblong, slightly flattened; skin creamy white, eyes prominent. Quality rather poor. Productive.	Medium.
Crandall's Beauty.	Size below medium, rather short; skin creamy-white, splashed with carmine, eyes deep. Quality poor to medium. Not productive.	Medium.
Crane's June Eating.	Size medium or below, oval, slightly flattened; skin white or flesh color, eyes of medium depth. Quality medium. Moderately productive.	Early.
Cream City.	Size medium or below, roundish; skin creamy-white, eyes few and shallow. Quality rather poor. Not productive.	Early to medium.

VARIETIES OF POTATOES GROWN, &c.—Continued.

Name.	Description of Tubers.	Season of Maturity.
Crown Jewel.	Size medium, oblong; skin nearly white, eyes of medium depth. Quality good. Productive.	Early.
Dakota Red.	Size medium, short; skin red, often russety, eyes of medium depth. Quality poor to medium. Very productive	Medium to late.
Dreer's Standard.	Size medium, short; skin white, netted, eyes shallow. Quality medium. Not productive.	Early.
Dunmore.	Size medium, oblong, slightly flattened; skin white, russety, eyes shallow. Quality medium to poor. Productive.	Medium.
Early Albino.	Size medium, oval, flattened; skin white, eyes shallow, surface smooth. Quality medium to good. Moderately productive.	Early.
*Early Beauty of Hebron.	Size medium, not long; skin white, shaded with light red over much of the surface, eyes not deep. Quality very good. Moderately productive.	Early to medium.
Early Durham.	Size medium, oblong; skin light red, eyes shallow. Quality medium. Productive.	Early to medium.
Early Eight Weeks.	Size medium or below, oval or often nearly sperical; skin white, eyes of medium depth. Quality medium to poor. Moderately productive.	Early to medium.
Early Electric.	Size medium, oblong; skin light red, eyes of medium depth, surface smooth. Quality medium. Moderately productive.	Early.
Early Essex.	Size medium, oval, flattened; skin light red, flesh yellowish-white, eyes shallow. Quality medium to poor. Moderately productive.	Early to medium.
Early French Giant.	Size medium, half long; skin red, eyes deep. Quality poor. Not productive.	Early to medium.
Early Gem.	Size medium, oblong; skin light red, eyes shallow. Quality medium. Moderately productive.	Early to medium.
Early Illinois.	Size medium, oval, slightly flattened; skin white, finely netted, eyes few and small, surface smooth. Quality good.	Early.

VARIETIES OF POTATOES GROWN, &c.—Continued.

NAME.	DESCRIPTION OF TUBERS.	Season of Maturity.
Early King.	Size medium or above, short, often nearly spherical or kidney form; skin white, russety, eyes rather deep. Quality poor. Productive.	Medium.
Early Maine.	Size medium, of the Early Rose type; skin light red, russety, eyes shallow. Quality good. Moderately productive.	Early.
Early Ohio.	Size medium or above, half long; skin light red, eyes rather deep. Quality medium to good. Moderately productive.	Early.
Early Perfection.	Size medium, oblong; skin light red, coarsely netted, eyes of medium depth. Quality medium. Moderately productive.	Early to medium.
Early Rose.	Size medium, oblong; skin light red, eyes shallow. Quality good. Moderately productive.	Early.
***Early Puritan.**	Size medium, oval; skin white, eyes shallow. Quality medium to good. Moderately productive.	Early.
Early Sunrise.	Size medium, of the Early Rose type; skin light red, eyes shallow. Quality medium to good. Moderately productive.	Early.
***Early Vermont.**	Size medium, of the Early Rose type; skin light red, eyes shallow. Quality good. Productive.	Early.
Early Washington.	Size medium, oblong, slightly flattened; skin light red, coarsely netted, eyes shallow. Quality medium to poor. Moderately productive.	Early to medium.
Early Waterford.	Size medium, oblong; skin light red, eyes of medium depth. Quality medium. Moderately productive.	Early to medium.
Empire State.	Size large, oblong, often nearly cylindrical; skin white, russety, eyes shallow, frequently prominent. Quality good. Productive.	Early to medium.
Eno's Seedling.	Size medium, oblong; skin white, russety, eyes very shallow. Quality medium. Moderately productive.	Medium to late.
Eureka.	Size medium, oval, flattened; skin white, very russety, eyes few and shallow. Quality good. Moderately productive.	Medium to late.

VARIETIES OF POTATOES GROWN, &c.—Continued.

NAME.	DESCRIPTION OF TUBERS.	Season of Maturity.
Eyeless.	Size medium, oval, frequently tapering towards the seed end; skin white, eyes small and few, surface smooth. Quality rather poor. Moderately productive.	Medium to late.
Farina.	Size below medium, very long, tapering towards the ends; skin white, finely netted, eyes shallow. Quality medium to good. Moderately productive.	Early to medium.
Frogner's No. 50.	Size medium, oval, flattened; skin light red, eyes shallow. Quality medium. Moderately productive.	Early.
Gen. Logan.	Size medium, nearly spherical, often flattened; skin russety, shaded with light red, eyes shallow. Quality good. Moderately productive.	Early to medium.
Gold Band.	Size medium, oblong; skin light red, with indistinct zones and patches of yellowish white, eyes shallow. Quality good. Moderately productive.	Medium.
Goucher.	Size medium, short, often flattened; skin white, netted, eyes shallow. Quality medium. Productive.	Medium.
Gov. Foraker.	Size medium, oblong; skin brownish red, eyes not deep, surface slightly uneven. Quality medium to poor. Moderately productive.	Medium.
Granger.	Size medium, oval, flattened; skin light red, eyes small, not deep. Quality medium. Moderately productive.	Medium.
***Green Mountain.**	Size medium to large, oblong, flattened; skin white, russety, eyes shallow, surface smooth and handsome. Quality good. Productive.	Medium to late.
Gregory's No. 1.	Size medium, oval, often flattened; skin creamy-white, shaded with light red, eyes shallow. Quality medium. Moderately productive.	Medium.
Hampden Beauty.	Size medium or above, oval, often flattened; skin white, slightly russety, eyes shallow, surface smooth. Quality good. Moderately productive.	Early to medium.

VARIETIES OF POTATOES GROWN, &c.—Continued.

Name.	Description of Tubers.	Season of Maturity.
Home Comfort.	Size medium, long, generally flattened; skin brownish red, eyes shallow, surface smooth with numerous russet spots. Quality medium to good. Moderately productive.	Medium to late.
Howe's Premium.	Size medium, nearly spherical; skin white, shaded with pink particularly about the eyes which are of medium depth. Quality medium to good. Moderately productive.	Early.
Idaho.	Size medium, oblong; skin white, russety, eyes shallow. Quality medium. Moderately productive.	Medium.
Improved English.	Size medium or below, rather short; skin red, eyes of medium depth, surface uneven. Quality medium to poor. Moderately productive.	Medium to late.
Iowa Beauty.	Size medium or below, oval, often flattened; skin creamy-white, shaded with light red, eyes shallow. Quality medium to good. Moderately productive.	
Jones' Prize Taker.	Size medium, oblong, sometimes irregular; skin nearly white, russety. Quality medium. Very productive.	Medium to late.
Jordan Russet.	Size medium, oval; skin white, coarsely netted over the entire surface, eyes nearly round and of medium depth. Quality medium. Moderately productive.	Medium.
Late Beauty of Hebron.	Size medium, oval; skin creamy-white, shaded with light red, eyes of medium depth. Quality good. Moderately productive.	Medium to late.
Late Rose.	Size medium or above, oblong, often tapering towards the seed end; skin light red, russety, eyes shallow. Quality good. Moderately productive.	Medium to late.
Late Snowflake.	Size medium, oval, flattened; skin white, very russety, eyes shallow, surface smooth. Quality good. Moderately productive.	Late.
Lee's Favorite.	Size medium, oval, flattened; skin yellowish-white, shaded with pink, eyes shallow. Quality medium. Moderately productive.	Early.

VARIETIES OF POTATOES GROWN, &c.—Continued.

Name.	Description of Tubers.	Season of Maturity.
Lombard.	Size medium to large, oblong or often tapering towards the seed end; skin white, eyes not deep. Quality medium to poor. Moderately productive.	Medium.
Louisa.	Size medium, rather long; skin light red, eyes shallow. Quality good. Moderately productive.	Medium to late.
Magnum Bonum. (American.)	Size medium to large, nearly spherical; skin white, coarsely netted, eyes deep, surface uneven. Quality medium. Moderately productive.	Medium.
Mammoth Pearl.	Size large. rather short, often flattened; skin white, slightly russety, eyes shallow. Quality medium to poor. Moderately productive.	Late.
Mayflower.	Size medium or above, oblong; skin white, shaded with light red, russety, eyes of medium depth. Quality medium to good. Productive.	Early to medium.
Mexican Wild.	Size small, nearly spherical; skin yellowish-white, eyes deep, surface uneven, flesh yellowish-white when cooked. Quality poor. Not productive.	Medium to late.
Minister.	Size medium, oblong, often flattened; skin light red, eyes rather deep. Quality medium to good. Productive.	Early.
Mitchell's Seedling.	Size medium, nearly spherical or often flattened; skin purple, netted, frequently with patches of russet, eyes not deep. Quality good. Moderately productive.	Medium to late.
Moore's Seedling.	Size medium, oval, slightly flattened; skin light red, coarsely netted, eyes of medium depth. Quality medium to good. Productive.	Medium.
Morning Star.	Size medium or above, oblong, often tapering towards the seed end; skin white, slightly russety, eyes very shallow, surface smooth. Quality medium. Productive.	Early to medium.
Mrs. Foraker.	Size medium, oval; skin white, russety, eyes shallow, surface smooth. Quality medium to good. Moderately productive.	Early to medium.

VARIETIES OF POTATOES GROWN, &c.—Continued.

NAME.	DESCRIPTION OF TUBERS.	Season of Maturity.
New Champion.	Size medium, oblong, nearly cylindrical; skin white, often with russet patches, eyes numerous but shallow. Quality good. Moderately productive.	Medium.
Newton's Seedling.	Size medium, oval; skin white, smooth, eyes not deep, pink. Quality medium. Productive.	Medium to late.
Nott's Victor.	Size medium, oblong or often tapering towards the seed end; skin white, shaded with pink, eyes shallow, pink. Quality medium. Productive.	Early to medium.
Ohio Junior.	Size medium, oval; skin light red, eyes not deep. Quality medium to good. Moderately productive.	Early.
Orange Co. White.	Size medium, oblong, often tapering towards the seed end; skin white, russety, eyes shallow. Quality medium to good. Very productive.	Medium.
Paris Rose.	Size medium, oblong, skin light red, russety, eyes shallow. Quality medium to good. Moderately productive.	Medium.
Pearl of Savoy.	Size medium, oblong; skin light red, eyes shallow. Quality medium to good. Productive.	Early.
Potentate.	Size medium or above, nearly spherical or often flattened; skin white, russety, eyes shallow. Quality medium. Moderately productive.	Early to medium.
Pride of America.	Size medium, oval; skin creamy-white, smooth, eyes shallow. Quality medium to good. Moderately productive.	Medium.
Pride of Erin.	Size medium, rather short, and frequently truncated at the ends; skin creamy-white, eyes shallow. Quality medium to poor. Productive.	Medium.
Pride of Palestine.	Size medium or below, oval, often flattened; skin white, flesh often shaded with pink, eyes shallow. Quality medium. Moderately productive.	Medium.
Pride of Wisconsin.	Size medium or below, nearly spherical; skin light red, eyes shallow. Quality medium. Moderately productive.	Medium.

VARIETIES OF POTATOES GROWN, &c.—Continued.

NAME.	DESCRIPTION OF TUBERS.	Season of Maturity.
Pride of the West.	Size medium, oval; skin white, eyes shallow. Quality medium to poor. Productive.	Medium.
Princess.	Size medium, oblong, or tapering towards the seed end; skin light red, eyes shallow. Quality medium. Moderately productive.	Early to medium.
Putman's Seedling.	Size medium, oval, slightly truncated at the ends; skin white, russety, eyes few, shallow. Quality good. Moderately productive.	Medium.
Queen of Roses.	Size medium, oblong or tapering towards the seed end; skin light red, eyes shallow. Quality good. Productive.	Early to medium.
Rocky Mountain Rose.	Size medium, oval; skin light red, russety, eyes shallow. Quality medium to poor. Productive.	Early to medium.
Rose of Hebron.	Size medium, oblong, skin yellowish white, shaded with light red, eyes shallow. Quality medium. Moderately productive.	Early to medium.
Rose's Invincible.	Size medium, oblong, often flattened; skin light red, eyes of medium depth. Quality medium. Moderately productive.	Medium to late.
Rural Blush.	Size medium, oblong, often truncated at the ends; skin light red, netted. Quality medium to good. Moderately productive.	Early to medium.
Seedling of Peerless.	Size medium, oblong, or tapering towards the seed end; skin white with a shade of light red, eyes shallow. Quality medium to good. Moderately productive.	Medium.
Silver Chili.	Size medium, oblong, tapering towards the seed end; skin nearly white, shaded with light red, eyes shallow. Quality medium. Productive.	Medium.
Stanton's Seedling.	Size medium, oval; skin light red, eyes rather deep, surface uneven. Quality medium. Moderately productive.	Medium.
Steuben's Chief.	Size medium, oblong, often flattened and truncated at the ends; skin light red, eyes shallow. Quality medium or below. Moderately productive.	Medium.
Stoor's Seedling.	Size medium, often flattened; skin light red, eyes of medium depth. Quality rather poor. Moderately productive.	Medium to late.

VARIETIES OF POTATOES GROWN, &c.—Continued.

NAME.	DESCRIPTION OF TUBERS.	Season of Maturity.
Stray Beauty.	Size medium, nearly spherical or sometimes flattened; skin red, eyes of medium depth. Quality medium. Moderately productive.	Early to medium.
Summit.	Size medium, oblong, frequently tapering towards the seed end; skin light red, russety, eyes shallow, surface smooth. Quality medium to good. Productive.	Early to medium.
Sunlit Star.	Size medium, oblong; skin light red, or sometimes nearly white, eyes of medium depth. Quality medium. Productive.	Early to medium.
***Thorburn.**	Size medium, oblong; skin light red, shaded with deeper red, eyes shallow. Quality good. Productive.	Early to medium.
Timpe's No. 6.	Size medium or above, oblong; skin nearly white, shaded with light red, eyes of medium depth. Quality medium to good. Productive.	Medium.
Tonbocks.	Size medium, oblong; skin creamy-white, shaded with light red, eyes shallow. Quality medium. Productive.	Early to medium.
Vanguard.	Size medium, oval; skin light red, eyes shallow, surface smooth. Quality medium. Moderately productive.	Early.
Vermont Champion.	Size medium, short, often flattened; skin white or brownish, coarsely netted, eyes of medium depth. Quality medium. Productive.	Medium.
Vick's Extra Early.	Size medium or below, oval; skin white, shaded and splashed with pink and carmine, eyes shallow. Quality medium. Moderately productive.	Early.
***Victory.**	Size medium to large, oblong, generally tapering towards the seed end; skin light red, eyes noticeably oblique, rather deep. Quality medium to good. Very productive.	Early.
Webb's Early.	Size medium, oval, often flattened; skin light red, coarsely netted, eyes of medium depth. Quality medium to good. Moderately productive.	Early to medium.

VARIETIES OF POTATOES GROWN, &c.—Continued.

Name.	Description of Tubers.	Season of Maturity.
Weld's No. 22.	Size medium, rather short, frequently truncated at the ends; skin light red, eyes of medium depth. Quality medium to poor. Moderately productive.	Medium.
White Elephant.	Size large, oblong; skin white, shaded with light red, eyes rather deep. Quality medium to good. Productive.	Medium to late.
White Flower.	Size medium, rather long, often flattened; skin creamy-white, slightly netted and often with numerous russet dots, eyes shallow. Quality medium. Moderately productive.	Medium to late.
White Rose. (Andrews.)	Size medium, oval, flattened; skin white, russety, eyes few, shallow, surface smooth. Quality medium. Productive.	Medium.
White Seedling.	Size large, oblong or variable in form; skin creamy-white, smooth, eyes shallow often shaded with pink. Quality medium. Very productive.	Medium to late.
Winslow's Seedling.	Size medium to large, oblong; skin light red, coarsely netted, eyes of medium depth. Quality medium to good. Moderately productive.	Medium.

LIST OF THE VARIETIES OF POTATOES GROWN AT THE EXPERIMENT STATION, WITH THE YIELD OF EACH, CALCULATED TO BUSHELS AND HUNDREDTHS OF A BUSHEL PER ACRE.

NAME.	YIELD.	NAME.	YIELD.
Alexander's Prolific	479.16 bush.	Connecticut	319.44 bush.
American Giant	233.77 "	Country's Pride	377.52 "
Angell's No. 27	387.20 "	Crandall's Beauty	195.02 "
Arctic	348.48 "	Crane's June Eating	297.66 "
Badger State	290.07 "	Cream City	168.35 "
Baker's Imperial	326.70 "	Crown Jewel	366.62 "
Banana	348.48 "	Dakota Red	435.60 "
Belle	304.92 "	Dreer's Standard	145.20 "
Ben. Harrison	309.76 "	Dunmore	435.60 "
Bill Nye	......	Early Albino	290.07 "
Bliss' Triumph	261.52 "	Early Beauty of Hebron	292.82 "
Bliss' Diamond	242.83 "	Early Durham	387.20 "
Boley's Northern Spy	329.12 "	Early Eight Weeks	193.60 "
Bonanza	457.38 "	Early Electric	188.78 "
Boston Market	309.76 "	Early Essex	309.76 "
Brook's Seedling	343.12 "	Early French Giant	338.80 "
Brown Beauty	145.20 "	Early Gem	239.58 "
Brownell's No. 31	290.40 "	Early Illinois	396.88 "
Brownell's No. 55	283.14 "	Early King	363.00 "
Brownell's Success	196 02 "	Early Maine	295.20 "
Brownell's Winner	348.48 "	Early Ohio	215.38 "
Buffalo Beauty	379.42 "	Early Perfection	258.12 "
Burbank's Seedling	387.20 "	Early Rose	227.48 "
Burpee's Extra Early	393.68 "	Early Puritan	326.70 "
Burpee's Superior	315.08 "	Early Sunrise	275.88 "
Canada Prince Albert	416.24 "	Early Vermont	348.31 "
Cayuga	319.44 "	Early Washington	309.76 "
Cambridge Prolific	471.90 "	Early Waterford	......
Champion of America	319.44 "	Empire State	425.92 "
Champlain	435.60 "	Eno's Seedling	285.14 "
Chas. Downing	458.83 "	Eureka	304.90 "
Cherry Blow	435.60 "	Eyeless	203.28 "
Chessman's Seedling	363.00 "	Farina	299.89 "
Chicago Market	319.44 "	Frogner's No. 50	271.04 "
Chicago Sun	338.80 "	Gen. Logan	297.72 "
Churchill's Seedling	275.88 "	Gold Band	326.42 "
Clark's No. 1	312.18 "	Goucher	396.88 "
Climax	333.96 "	Gov. Foraker	280.72 "
Colvin's Superb	290.40 "	Granger	302.50 "

POTATOES GROWN AT EXPERIMENT STATION, &c.—Continued.

NAME.	YIELD.		NAME.	YIELD.	
Green Mountain	399.40	bush.	Pride of America	245.27	bush.
Gregory's No. 1	309.76	"	Pride of Palestine	228.84	"
Hampden Beauty	275.88	"	Pride of Wisconsin	212.96	"
Home Comfort	283.14	"	Pride of the West	333.96	"
Howe's Premium	275.30	"	Princess	338.80	"
Idaho	300.08	"	Putman's Seedling	364.25	"
Improved English	217.97	"	Queen of Roses	329.52	"
Iowa Beauty	348.48	"	Rocky Mountain Rose	343.62	"
Jones' Prize Taker	467.06	"	Rose of Hebron	268.63	"
Jordan Russet	295.24	"	Rose's Invincible	248.99	"
Late Beauty of Hebron	339.12	"	Rural Blush	278.30	"
Late Rose	271.06	"	Seedling of Peerless	290.07	"
Late Snow Flake	242.00	"	Silver Chili	304.90	"
Lee's Favorite	260.36	"	Stanton's Seedling	312.40	"
Lombard	242.83	"	Steuben's Chief	290.40	"
Louisa	326.70	"	Stoors' Seedling	297.30	"
Magnum Bonum (American)	294.03	"	Stray Beauty	309.76	"
			Summit	426.19	"
Mammoth Pearl	258.95	"	Sunlit Star	348.51	"
Mayflower	358.16	"	Thorburn	313.78	"
Mexican Wild	......		Timpe's No. 6	......	
Minister	425.92	"	Tonhocks	306.62	"
Mitchell's Seedling	261.36	"	Vanguard	284.96	"
Moore's Seedling	331.54	"	Vermont Champion	382.36	"
Morning Star	333.96	"	Vick's Extra Early	314.60	"
Mrs. Foraker	329.12	"	Victory	571.12	"
New Champion	246.84	"	Webb's Early	370.46	"
Newton's Seedling	343.64	"	Weld's No. 22	324.28	"
Nott's Victor	336.38	"	White Elephant	348.48	"
Ohio Junior	193.60	"	White Flower	338.80	"
Orange County White	442.10	"	White Rose (Andrews)	460.16	"
Paris Rose	290.07	"	White Seedling	590.48	"
Pearl of Savoy	333.96	"	Winslow's Seedling	297.64	"
Potentate	268.62	"			

THE DOWNY MILDEW OF THE POTATO OR THE POTATO BLIGHT.*

The disease of the potato, caused by the parasitic fungus *Phytophthora infestans*, D. By., generally known as the potato rot, probably originated in South America, whence it was brought to this country about the year 1840. Since that time it has been the cause of very serious losses to farmers, and in years favorable to the disease it has swept away nearly the entire crop. No variety has yet been discovered that has remained free from the disease under all circumstances, although in some localities some varieties are more resistant than others.

The first indication of the presence of the disease is the appearance of pale, yellowish spots upon the leaves. Soon the fungus pushes out its fruiting threads, which appear as a white, downy coating on the surface, and if the atmosphere is warm and damp, the discoloration of the leaves proceeds rapidly, the spots becoming nearly black, indicating the total destruction of the tissues. The stems are usually attacked a little later than the leaves, but in a similar manner, and like them quickly blacken and die. The fungus soon reaches the tubers, either through the roots, or by the spores being washed into the soil, and attains a considerable growth within the tissues before there is any external manifestation of its presence. After a time depressed spots appear and the skin covering these, dies and becomes discolored. The flesh beneath these spots is dark colored and diseased to a greater or less depth, and in the end the entire tuber usually decays.

CONDITIONS FAVORING THE DISEASE.

These are (1) humidity—the years of great outbreaks have always been years of excessive humidity; (2) a temperature ranging from 65° to 75° F.—a few degrees above 74° will check the

* The substance of this article was taken from a paper by Prof. F. L. Scribner.

development entirely, and down to 45° the fungus will continue to grow; (3) moisture in the soil—hence a clayey soil or one that will retain moisture is more favorable to the potato rot. The conditions which favor the rot after the potatoes are harvested are the same as those which favored it before—moisture and moderately high temperature.

The Bordeaux Mixture as a Preventive of the Potato Blight; Experiments with, at this Station.

About four years ago, through the efforts put forth by the section of Vegetable Pathology, at Washington, the use of preparations of the Salts of Copper—chief of which is the *Bordeaux* Mixture—was introduced into this country as a preventive of the Downy mildew and Black rot of the grape. So marked were the results obtained by the use of the fungicides that it is now estimated* that nearly five thousand grape growers, in all parts of the country, treated their vineyards for *Mildew* and the *Black rot* during the past year, and that the amount of fruit saved in this way will vary from 50 to 90 per cent. of the crop. From a knowledge of the fact that the fungus which causes the *Mildew* and *Black rot* of the grape, is very similar in character to that which produces the *Potato blight* and *rot*, it was suggested that the remedies found useful in preventing the ravages of the one might prove equally applicable to the other.

In France, experiments were made with the Bordeaux Mixture upon potato and tomato vines in 1886, but previous to the season of 1889 only a comparatively small number of such experiments had been recorded in this country.

It is true that the results of those and the experiments of the past season have been somewhat variable in character, but it must

* Report of the Secretary of Agriculture, 1890.

be remembered that this line of work is entirely new; there is no beaten path of precedent to follow, consequently it is to be expected that failure will sometimes be the result of our efforts.

Details of the Experiment.

A section of the potato field (see illustration, Fig. 1) where the trial of varieties and methods of planting experiments were being conducted was set apart for this work; growing in this section there were 60 rows of potatoes, each 50 ft. long, or two rows each of 30 varieties—including those of early, medium and late seasons of maturity. The section was planted May 10th, and the growth during the season was unusually even. July 11th indications of the presence of the *blight* were discovered upon a few hills, and the following day, July 12th, the first application of the *Bordeaux* Mixture was made. The section having been divided into four equal plots of 15 rows each, the vines were sprayed with the mixture as follows:

In plots Nos. 1, 3 and 4, July 12th, 23d and Aug. 2d. In plot No. 1, Aug. 16th and 30th, or plots Nos. 3 and 4—which were duplicates of plots Nos. 1 and 2, and to be used as check plots in the experiment—each received three applications of the mixture. Plot No. 1 received five applications of the mixture and plot No. 2 remained untreated during the entire season. The accompanying tables contain the results of the experiment, by plots, as follows:

In the first three double columns, the yields of merchantable and small potatoes and the total product, respectively, of each variety by weight and number. In the fourth column, the average weight of the individual tubers of each variety, and in the fifth column the per cent. of each variety, by number, affected by the potato rot. The rows were each 50 ft. long and 3 ft. apart, and the hills 18 inches apart in the rows. The yield is given in pounds and tenths of a pound, and the average weight of the individual tubers in ounces and tenths of an ounce.

PLOT NO. 1.

The vines receiving *five applications* of the Bordeaux Mixture during the season.

VARIETY.	Merchantable.		Small.		Total.		Individual Tubers. Average weight of.	Per cent. affected by rot (by number.)
	Weight.	Number.	Weight.	Number.	Weight.	Number.		
	lbs.		lbs.		lbs.		oz.	pr. ct.
American Giant........	70.5	204	11.5	83	82.0	287	4.6	3.5
Am. Magnum Bonum..	79.3	138	9.3	87	88.6	225	6.3	4.1
Buffalo Beauty.........	100.0	150	9.5	75	109.5	225	7.7	1.3
Bonanza..............	77.0	105	15.0	163	92.0	268	5.5	23.4
Burpee's Superior......	70.0	182	10.0	112	80.0	294	4.3	4.1
Brownell's No. 31......	41.5	195	29.0	246	70.5	441	2.5	0.0
Brownell's No. 55......	71.0	277	28.0	245	99.0	522	3.0	1.9
Baker's Imperial.......	49:0	128	33.0	107	82.0	235	5.6	0.0
Champlain.............	70.0	239	18.0	190	88.0	429	3.3	0.0
Colvin's Superb........	58.0	256	16.5	140	74.5	396	3.0	0.0
Crown Jewel..........	67.0	246	18.0	210	85.0	456	2.9	2.2
Crane's June Eating ...	50.0	180	13.0	210	63.0	390	2.5	0.0
Cayuga...............	83.0	260	8.0	35	91.0	295	4.9	1.1
Cherry Blow...........	50.0	203	8.5	133	58.5	336	2.8	1.5
Chas. Downing........	81.0	262	11.0	149	92.0	411	3.6	0.0
Sum.............	1017.3	3025	238.3	2185	1256.0	5210	62.5	43.1
Average...........	67.8	201.7	15.9	145.6	83.7	347.3	4.2	2.9

PLOT NO. 2.

The vines remaining *untreated* during the entire season.

VARIETY.	Merchantable.		Small.		Total.		Individual Tubers. Average weight of.	Per cent. affected by rot (by number.)
	Weight.	Number.	Weight.	Number.	Weight.	Number.		
	lbs.		lbs.		lbs.		oz.	pr. ct.
Alexander's Prolific....	76.0	180	14.5	190	90.5	370	3.9	18.0
Bliss' Triumph.........	44.3	190	25.0	256	69.3	446	2.5	0.0
Brook's Seedling.......	69.0	220	4.0	56	73.0	276	4.2	0.0
Belle..................	56.0	180	2.5	18	58.5	198	4.7	1.5
Banana.................	47.0	153	8.0	79	55.0	232	3.8	4.3
Brownell's Success.....	32.0	135	27.0	240	59.0	375	2.5	0.8
Borough's Garfield	54.0	193	16.0	172	70.0	365	3.0	1.1
Crandall's Beauty......	26.5	180	20.0	250	46.5	430	1.7	2.3
Clark's No. 1..........	51.0	206	19.0	173	70.0	379	2.9	0.0
Climax.................	57.0	194	13.0	163	70.0	357	3.1	7.8
Connecticut............	43.0	160	19.0	246	62.0	406	2.0	6.5
Churchill's Seedling....	40.0	147	16.0	250	56.0	397	2.3	0.8
Chessman's Seedling...	69.0	220	4.0	56	73.0	276	4.2	0.0
Chicago Market........	42.0	195	15.0	163	57.0	358	2.5	0.0
Centennial.............	50.0	145	19.0	145	69.0	290	3.8	2.0
Sum..............	756.8	2698	222.0	2457	978.8	5155	47.1	45.1
Average..........	50.4	179.9	14.8	163.8	65.2	343.7	3.1	3.0

PLOT NO. 3.

The vines receiving *three applications* of the Bordeaux Mixture.

VARIETY.	Merchantable.		Small.		Total.		Individual Tubers. Average weight of.	Per cent. affected by rot (by number.)
	Weight.	Number.	Weight.	Number.	Weight.	Number.		
	lbs.		lbs.		lbs.		oz.	pr. ct.
American Giant........	39.5	111	8.3	105	47.8	216	3.5	15.3
Am. Magnum Bonum..	54.0	174	6.0	33	60.0	207	4.6	3.5
Buffalo Beauty.........	66.0	186	12.5	153	78.5	339	3.7	7.0
Bonanza..............	78.0	195	16.5	162	94.5	357	4.2	20.0
Burpee's Superior......	54.0	228	10.5	111	64.5	339	3.0	6.5
Brownell's No. 31.....	39.0	204	21.0	210	60.0	414	2.3	0.0
Brownell's No. 55.....	42.0	201	16.5	231	58.5	432	2.1	0.2
Baker's Imperial.......	60.0	186	7.5	85	67.5	271	3.9	1.8
Champlain............	81.0	345	9.0	129	90.0	474	3.0	1.2
Colvin's Superb.......	55.5	241	4.5	160	60.0	401	2.4	1.4
Crown Jewel	51.0	210	24.7	228	75.7	438	2.7	1.8
Crane's June Eating...	51.0	198	10.5	157	61.5	355	2.8	0.0
Cayuga................	58.5	201	7.5	27	66.0	228	4.6	0.4
Cherry Blow..........	46.0	261	9.0	108	55.0	369	2.4	2.7
Chas. Downing........	78.0	235	16.5	325	94.5	560	2.7	1.3
Sum.............	853.5	3176	180.5	2224	1034.0	5400	47.9	63.1
Average..........	56.9	211.7	12.0	148.2	68.9	360.0	3.2	4.2

PLOT NO. 4.

The vines receiving *three applications* of the Bordeaux Mixture.

VARIETY.	Merchantable.		Small.		Total.		Individual Tubers. Average weight of.	Per cent. affected by rot (by number.)
	Weight.	Number.	Weight.	Number.	Weight.	Number.		
	lbs.		lbs.		lbs.		oz.	pr. ct.
Alexander's Prolific....	90.0	264	9.0	117	99.0	381	4.1	7.1
Bliss' Triumph.........	56.0	150	15.5	144	71.5	294	3.9	0.0
Brook's Seedling.......	60.0	141	9.5	105	69.5	246	4.5	2.8
Belle.................	60.0	114	3.0	45	63.0	159	6.3	0.2
Banana................	60.0	192	12.0	150	72.0	342	3.3	0.1
Brownell's Success	40.0	150	20.5	132	60.5	282	3.4	0.0
Borough's Garfield.....	60.0	168	12.0	159	72 0	327	3.5	0.0
Crandall's Beauty......	21.0	120	19.5	276	40.5	396	1.6	0.0
Clark's No. 1..........	57.0	201	7.5	91	64.5	292	3.5	0.0
Climax................	54.0	207	15.0	62	69.0	269	4.1	4.0
Connecticut...........	54.0	222	12.0	141	66.0	363	2.9	3.3
Churchill's Seedling....	48.0	222	9.0	129	57.0	351	2.6	0.0
Chessman's Seedling...	69.0	204	6.0	75	75.0	279	4.3	0.0
Chicago Market........	54.0	168	12.0	123	66.0	391	2.7	0.0
Centennial............	48.0	189	16.0	150	64.0	339	3.0	0.5
Sum..............	831.0	2712	178.5	1899	1009.5	4711	53.7	18.0
Average...........	55.4	180.8	11.9	126.6	67.3	314.1	3.6	1.2

A summary of the preceding four tables, arranged for the comparison of the *averages* of the results obtained in the experiment, is as follows:

Plot.	Merchantable.		Small.		Total.		Individual Tubers. Weight of.	Per cent. affected by rot (by number.)
	Weight.	Number.	Weight.	Number.	Weight.	Number.		
	lbs.		lbs.		lbs.		oz.	pr. ct.
No. 1	67.8	201.7	15.9	145.6	83.7	347.3	4.2	2.9
No. 2	50.4	179.9	14.8	163.8	65.2	343.7	3.1	3.0
No. 3	56.9	211.7	12.0	148.2	68.9	360.0	3.2	4.2
No. 4	55.4	180.8	11.9	126.6	67.3	314.1	3.6	1.2

The figures obtained from plot No. 2, show the results where no Bordeaux Mixture was used. By comparing the figures from plot No. 2 with those from plot No. 4, we have the benefits arising from the *three applications* of the mixture, and by comparing the figures from plot No. 2 with those from plot No. 1, and adding or subtracting, as the case may require, the difference between the results in plots Nos. 3 and 4, as a correction for any variation in the results that might be due to the constitutional differences of the varieties, the actual benefits arising from the *five applications* of the mixture are obtained.

Conclusions Drawn from the Comparison of the Results in Plots Nos. 2 and 4.

First. The yield of merchantable potatoes was increased 9.9 per cent. by spraying the vines *three* times with the Bordeaux Mixture.

Second. The larger yield was due to an increase in the size of the tubers and not to an increase in number.

Third. The per cent. (by number) affected by the rot, was one and one-half times, or 150 per cent. greater in plot No. 2, where no mixture was used, than in plot No. 4 where three applications were made.

Conclusions Drawn from a Comparison of the Results in Plots Nos. 1 and 2.

Fourth. The yield of merchantable tubers was increased 34.5 per cent. by spraying the vines *five* times with the Bordeaux Mixture.

Fifth. The application of the mixture did not increase the total number of tubers formed.

Sixth. The average weight of the individual tubers was 35.5 per cent. more in plot No. 1 than in plot No. 2, or, if we add to this the 12.5 per cent. difference shown in the average weights of the individual tubers in plots Nos. 3 and 4, we have 48.0 per cent. as the *actual* increase in the weight of the individual potatoes arising from the five applications of the Bordeaux Mixture.

Seventh. The per cent. of the potatoes affected by the rot in plots Nos. 1 and 2 varies but slightly; that is, it is but three and three-tenths of one per cent. less in plot No. 1 than in plot No. 2; but, again, if we add to this the correction for the constitutional differences of the varieties compared, shown in the difference of results in plots Nos. 3 and 4, we have as the actual benefit arising from the five applications of the Bordeaux Mixture an increase of 253.3 per cent. in the number of potatoes affected by the rot in plot No. 2 over plot No. 1.

The Formula used in Preparing the Bordeaux Mixture.

(1) Sulphate of Copper, 6 lbs., dissolved in 4 gallons of *hot* water.

(2) Lime, 4 lbs., dissolved in 4 gallons of *cold* water.

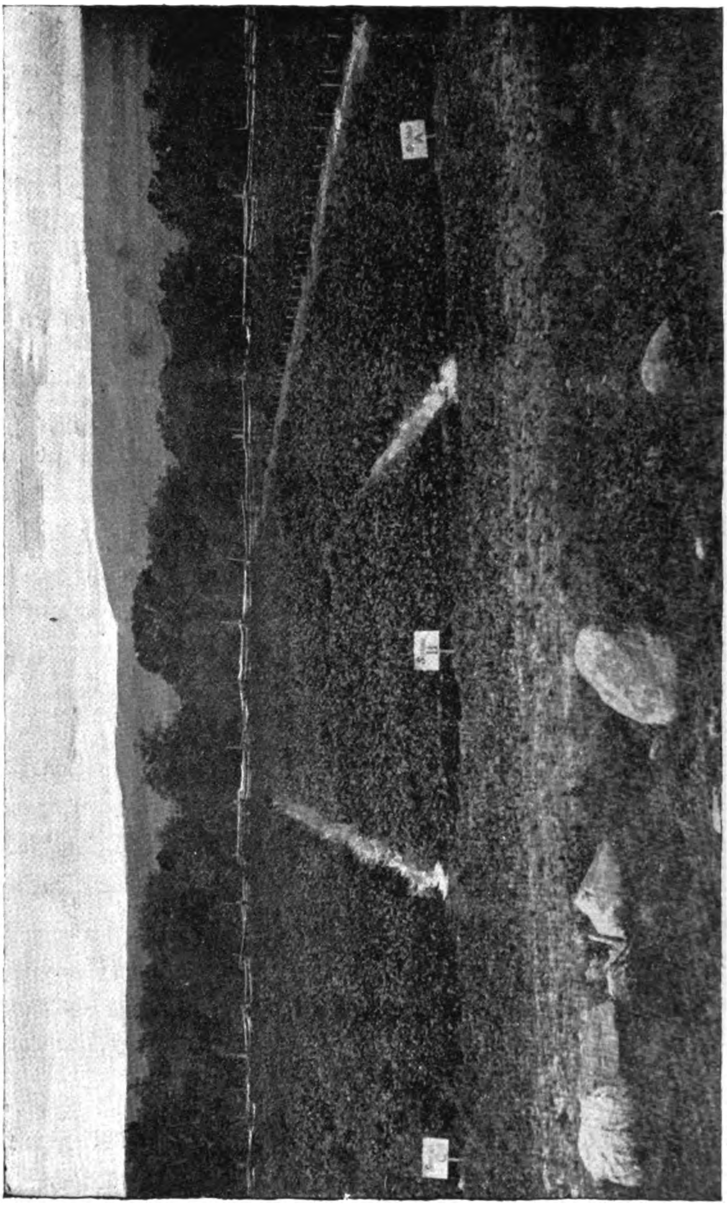


PLATE I. From a Photograph of the field where Experiment No. 1 with Potatoes was conducted—taken July 12th.

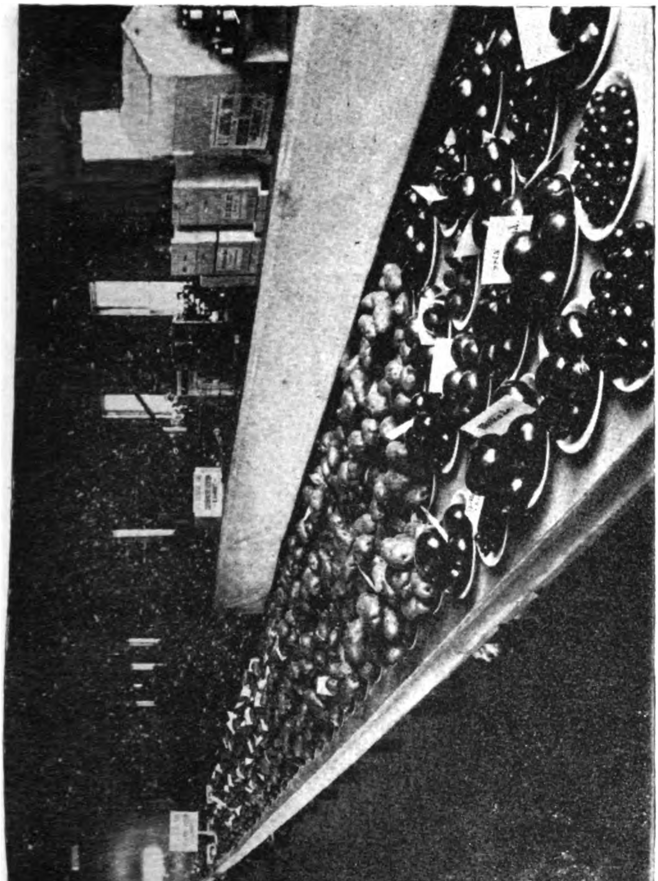


PLATE II. Exhibit of the Rhode Island State Agricultural Experiment Station at the Washington County Fair, September, 1890.

When cold, solution (2) was slowly and thoroughly mixed with solution (1), and when desired for use, it was diluted to 22 gallons with cold water, and strained.

For convenience, a large cask holding a quantity equal to eight times the above formula (before being diluted), was prepared at a time, at an expense of $3.36 for sulphate of copper and 24 cents for lime—or $3.60 for both—making the cost of the mixture, not including labor, when diluted and ready for use, a little less than 2½ cents per gallon.

The quantity required for a thorough application depends upon the abundance of the vines and the adaptation of the apparatus employed in the operation. The object to be attained is to distribute minute particles of the mixture over the entire green surface of the vines, for it is known that a very small quantity of the sulphate of copper will prevent the spores of the fungus from germinating, and, consequently, from infecting healthy plants. This may be accomplished by various simple means, but probably with greater economy and more effectually with some of the apparatus manufactured especially for the application of fungicides or insecticides.

A knapsack form of pump (see illustration), known as the "Eureka" Sprayer, and manufactured by Adams Weaber & Sons, of Vineland, N. J., was mainly used in our experiment. The pump proper is within the tank and connected with an air chamber. It is worked by a lever held in the right hand, while the left hand is free to direct the spray, which is very fine and the pressure constant. The tank holds five gallons of the mixture, and when filled and ready for use, weighs about 75 pounds. With it a man can easily and quickly reach all of the green parts of the plants, covering them with a thin film of copper.

Paris Green was added to the mixture used in the first two applications, at the rate of 1 lb. to 150 gallons of the mixture, and

proved effectual in the destruction of the larvæ of the potato beetle, then upon the vines.

PLATE III. Applying the Bordeaux Mixture with a "Eureka" Sprayer. From a Photograph.

In plot No. 1 there was used upon the 15 rows of potatoes, each 50 ft. long, in the five applications made during the summer, about 15 gallons, or at the rate of about 300 gallons per acre, of the mixture, for which the material cost 38 cents. By its use the yield of merchantable potatoes was increased 236.5 * lbs., or nearly four bushels, with a much smaller per cent. of the tubers affected by the rot.

It will, however, be noticed by a close examination of the tables given, that the results as related to individual varieties, have been more or less variable; this is, undoubtedly, due to the local conditions, in connection with the peculiarities of the various kinds; that is, the early varieties that had nearly matured their growth before the *blight* appeared were not benefited by the application of the mix-

* Correction deducted.

ture in so marked a degree as the later varieties, etc. Yet the plan was to include enough kinds in the experiment so that by considering the *averages* of a large number of results only, such differences would be mainly eliminated, and without overlooking the fact, that conflicting results were obtained in some individual cases, we feel justified, so far as is consistent with but a single year's experience and a review of the results of the limited number of experiments that have yet been recorded, in recommending the Bordeaux Mixture for general trial as a preventive of the potato blight and rot.

PLATE IV. From a Photograph of a section of the plot in the Potato Field where the Bordeaux Mixture Experiment was conducted.

Plate IV. is from a photograph taken on the field where the experiment was being conducted, Aug. 20th. The two rows in the centre of the figure were not treated with the mixture, consequently the leaves all blighted and withered up soon after Aug. 1st, leaving only the bare, dead stems when the photograph was taken; while the leaves and vines in the rows on either side, which had been sprayed with the Bordeaux Mixture, were fresh and green.

No. 1. No. 2.

PLATE V. From a Photograph of two hills of the Burpee's Superior Potato, illustrating the effect of the application of the Bordeaux Mixture.

Plate V. is from a photograph of two isolated hills of the Burpee's Superior Potato, taken Sept. 1st. The hills had grown side by side and had been subject to the same conditions, except that the vines of No. 2 were sprayed with the Bordeaux Mixture, at intervals of about two weeks from July 12th to Sept. 1st, inclusive, and as a result the leaves remained green and the tubers continued to grow until the date of the photographing. The vines of No. 1 were not treated with the mixture, and were attacked by the blight July 20th, which destroyed the vitality of the leaves almost entirely by Aug. 1st, and those remaining, with the vines, were completely blackened by the middle of August. The potatoes of No. 2, be-

sides being much larger than those of No. 1, were absolutely free from the indications of decayed spots, while among the potatoes of No. 1, there was one that was badly decayed and two others that had commenced to decay.

EXPERIMENT WITH PARSNIPS.

Ridge Compared with Flat Cultivation.

The plot where the experiment was conducted was prepared for planting as evenly as possible, with the exception that on one-half of the piece ridges were raised about eight inches above the surface by turning two furrows together, the soil on the sides and tops being smoothed off and packed together with a spade. The extra labor required in preparing the ridges was fully repaid in the care of the crop during the summer, but with the exception of a slight reduction in the per cent. of branched specimens, no advantage resulted in our trial of the *ridge* system over the more common method of flat cultivation. The locality and climatic conditions would, however, probably influence the results materially. The following tables contain the records of six rows, 30 ft. long by 2 ft. apart. The first three, with flat cultivation, gave the larger yield and higher average weight of the individual parsnips.

FLAT CULTIVATION.

	Merchantable.		Small.		Total.		Average weight.	Per cent. branched.
	Pounds.	Number.	Pounds.	Number.	Pounds.	Number.	oz.	pr. ct.
Row No. 1, (Hollow Crown).............	20.7	56	10.5	30	31.2	86	5.8	18.5
Row No. 2, (Student).	17.0	41	14.3	55	31.3	96	5.2	33.5
Row No. 3, (Hollow Crown)............	21.7	66	6.0	28	27.7	94	4.7	23.7
Sum..............	59.4	163	30.8	113	90.2	276	15.7	75.7
Average...........	19.8	54.3	10.3	37.7	30.1	92	5.2	25.2

RIDGE CULTIVATION.

	Merchantable.		Small.		Total.		Average weight.	Per cent. branched.
	Pounds.	Number.	Pounds.	Number.	Pounds.	Number.	oz.	pr. ct.
Row No. 4, (Hollow Crown).............	15.7	45	7.5	45	23.2	90	4.1	23.5
Row No. 5, (Student).	15.0	48	15.3	47	30.3	95	5.1	22.1
Row No. 6, (Hollow Crown)	11.8	39	11.3	78	23.1	117	3.2	16.0
Sum..............	42.5	132	34.1	170	76.6	302	12.4	61.6
Average...........	14.2	44	11.3	56.6	25.5	101	4.1	20.5

EXPERIMENT WITH FERTILIZERS. NO. 1.

May 31st, a plot having received during the winter an application of stable manure, at the rate of five cords per acre, was planted with twelve varieties of bush beans, two rows of a kind, forty feet long and two feet apart. The hills in the rows were four feet apart. About a month later, when the beans had come up nicely, the fertilizers enumerated in the accompanying table were carefully applied, at the rate of one thousand pounds per acre, around the hills, in rows crossing the rows of varieties at right angles. The fertilizers were then thoroughly mixed with the soil with a hoe. A check-row was left untreated between each two kinds of fertilizers. The average yield of these rows is given in the fifth column of the table. An inspection of the table shows the following results, viz:

1st. The application of *Dissolved Bone Black*, which was the least expensive of any of the fertilizers, increased the average yield of the twelve varieties 58.7 per cent.

2d. That the application of *Sulphate of Potash* increased the yield 38.1 per cent., and the application of *Muriate of Potash* only increased the yield 20.4 per cent.

3d. That the application of nitrogenous fertilizers, e. g., *Nitrate of Soda and Sulphate of Ammonia*, was not profitable.

BEANS.

Table showing the yield of twelve varieties, calculated to bushels and hundredths of a bushel per acre, where five special fertilizers were used.

VARIETY.	Dissolved Bone Black.	Sulphate of Potash.	Sulphate of Ammonia.	Nitrate of Soda.	Muriate of Potash.	No Fertilizer.	Average yield of Varieties.
Hatt's No. 1	40.07 bush.	27.80 bush.	20.16 bush.	26.61 bush.	40.33 bush.	25.21 bush.	30.05 bush.
Hatt's No. 2	35.29 "	28.16 "	28.16 "	20.16 "	20.16 "	27.73 "	26.61 "
Hatt's No. 3	32.77 "	27.73 "	25.21 "	27.73 "	28.16 "	25.21 "	27.80 "
Low's Champion	13.86 "	20.16 "	10.08 "	12.60 "	12.60 "	13.86 "	13.86 "
Golden Six Weeks	19.08 "	17.65 "	12.60 "	7.57 "	11.34 "	5.04 "	12.21 "
Dwarf Mont D'or	7.57 "	10.08 "	7.57 "	5.04 "	5.04 "	3.78 "	6.50 "
Ne Plus Ultra	17.65 "	11.34 "	5.04 "	5.04 "	10.08 "	8.82 "	9.66 "
Purple Flageolet	7.57 "	10.08 "	7.57 "	5.04 "	5.04 "	3.78 "	6.09 "
Round Podded Refugee	11.34 "	17.65 "	13.86 "	17.65 "	12.60 "	8.82 "	13.48 "
Red Valentine	17.65 "	12.60 "	7.57 "	19.08 "	11.34 "	7.57 "	12.63 "
Dwarf Case-knife	8.82 "	6.30 "	5.04 "	6.30 "	8.82 "	8.82 "	7.35 "
Wardwell's Kidney	16.38 "	8.82 "	7.57 "	7.57 "	7.57 "	5.04 "	9.16 "
Sum	228.05 bush.	198.37 bush.	150.43 bush.	160.39 bush.	173.08 bush.	143.68 bush.	175.40 bush.
Average	19.00 bush.	16.53 bush.	12.54 bush.	13.37 bush.	14.42 bush.	11.97 bush.	14.62 bush.

TRIAL OF LAWN GRASSES.

Rhode Island Bent (*Agrostis canina*) and Kentucky Blue-Grass (*Poa pratensis*), both alone, and with White Clover.

In preparing the land about the farm-house for a lawn, an area of about 17,000 square feet, or something less than a half acre, was divided into four sections; and when the preparation was complete, which consisted of plowing the land, and then cross-plowing it to a depth of eight or nine inches, leveling it with a Thomas' smoothing harrow, rolling with a hand roller, raking it, etc., the grass seeds were sown April 19th, at the rate of four bushels per acre, in the sections as follows:

In Section I., Rhode Island Bent; in Section II., Kentucky Blue-Grass; in Section III., Rhode Island Bent with white clover, at the rate of one-half bushel per acre, and in Section IV., Kentucky Blue-Grass with white clover as in Section III.

The clover seed germinated a few days earlier than the grasses and for the first three or four weeks added density to the forming sward; but later the growth was not so even where the clover seed was sown as in the other sections. The lawn mower which was used upon the lawn after June 10th could not be made to cut the clover as smoothly as the grasses.

The sward formed by the Rhode Island Bent in Section I., where sown alone, was from the first more even, finer and thicker than that formed in Section II. by the Kentucky Blue-Grass. To hasten and strengthen the growth of the young grass during the summer, Nitrate of Soda was sown, *very lightly*, at the rate of 75 lbs. per acre, over the lawn upon the following dates, viz: June 10th, 26th, and July 12th. These applications, although light, to avoid any risk of burning the tender blades of grass, in no case failed to produce an immediate fresh and deep green growth.

THE TRIAL OF NEW VARIETIES OF FRUITS AND VEGETABLES.

This we consider one of the most important lines of the work of the division, and one for which the demand is rapidly increasing. The susceptibility of our cultivated plants to indefinite improvement, leads to the constant introduction of new varieties, some of which are superior to those already grown but many of them inferior, or, indeed, nearly worthless as compared with the standard varieties of the time. So often has it happened that a highly recommended new variety has, upon trial, disappointed the purchasers, and thereby the nursery or seedsman who sent it out, that there is now a mutual desire on the part of the would be purchasers and dealers to adopt some measure by which their common interests will be protected; that is, the purchaser from paying a large price for something that is emphatically not adapted to his use, and the introducer from the expense of widely advertising an article which at the best will only prove of local value. That the originators of these new varieties readily avail themselves of the opportunity of having their novelties tried, is shown by the fact that during the past two years more than three hundred new varieties of fruits and vegetables have been sent to this station for trial, many of which have not yet been offered for sale. As proposed in a previous report, these new varieties are grown side by side with the standard kinds of their class, receiving good, but in no case special, cultivation, and their behavior carefully noted. From these notes reports are made to the introducers and in the bulletins, from time to time, as characteristic developments occur. The following notes are given as some of the results of last year's trials.

Notes on New Varieties of Strawberries.

Clinton.—This variety was received in the spring of 1889 from R. Ball, of Lyons, Iowa. The plants are strong and vigorous; the fruit rather long, of good size and color, but not high flavored; quite productive; season medium.

Itaska.—Plants of very vigorous growth; fruit often imperfect, and borne sparingly.

King's Seedling No. 2.—Received from Edwin King, of Wooster, Ohio. Habit of growth low but vigorous; fruit dark red, of mild acid flavor; season medium to late; only moderately prolific.

Lady Rusk.—Received from the Nouvoo Fruit Growers Association, of Nouvoo, Ill., in the spring of 1889. Foliage dark green, not heavy; flowers pistilate; fruit of medium size, bright color, firm, and of good quality. It is a strong grower, forming plants profusely, and a very prolific bearer.

Rogers.—This variety was received in the fall of 1889, and has not borne a full crop of fruit. The plants are vigorous and the fruit of good quality.

Seedling No. 3.—Received from Zanesville, Ohio. Plants of very strong growth; fruit large, but deficient in color and flavor; moderately productive; season late.

Stayman's No. 1.—Received from Stayman & Black, of Leavenworth, Kansas. Plants moderately vigorous; fruit slightly irregular in form; quality good; fairly productive; season medium.

Stayman's No. 2.—Received from Stayman & Black, of Leavenworth, Kansas. Foliage firm, not heavy; fruit of good size and quality; productive; season early. It is a promising new variety.

NEW VARIETIES OF POTATOES.

(For description see descriptive list.)

Ben. Harrison.—
Paris Rose.— } Received from L. H. Read, of Cabot, Vt.

Eyeless.—
Iowa Beauty.— } Received from the Iowa Seed Co., of Des Moines, Iowa.

Louisa.—Received from W. J. Shrop, of Rittman, Ohio.

Frogner's No. 50.—Received from S. Frogner, of Hermon, Minn.

Brownell's Winner.—
Burpee's Extra Early.— } Received from W. Atlee Burpee, of Philadelphia, Penn.

Timpe's No. 6.—Received from the Horticultural Department of the Michigan Agricultural College.

Seedling of Peerless.—Received from E. L. Coy, of West Hebron, N. Y.

MISCELLANEOUS NOTES.

Three varieties of white bush beans have been received from J. Hatt, of Argentine, Mich., numbered, respectively, 1, 2 and 3. There is a marked resemblance between the varieties, suggestive of a common origin. The vines are of strong, rank growth, and the foliage quite resistant to the blight. These varieties were more prolific than any other varieties of bush beans grown at the Station during the past season. (For yields see Fertilizer Experiment.)

Perfection Cauliflower.—Received from H. A. March, of Fidalgo, Washington. The seed was large and well matured, and pro-

duced strong and healthy plants, all of which matured good heads, as early or slightly earlier than Henderson's Early Snow-ball, under the same conditions.

Garden Lemon.—The seed of this interesting novelty was received from the Iowa Seed Co. in the spring of 1889. In growth it resembles our musk melons, but is not as vigorous. The fruit is about the size of lemons, or on rich soil, somewhat larger; in form not unlike the lemon, although less pointed and sometimes approaching spherical. The vines are very prolific in the formation of fruit, which is edible, but not pleasing to the taste in an uncooked state; when boiled, seasoned and served with melted butter, it makes a very attractive dish. The flesh is white, of fine texture, with a mild acid and slightly melon-like flavor. Preserved with spices it is exceedingly fine, and notwithstanding its small size, may prove a valuable acquisition to our list of choice garden vegetables.

Acknowledgment is hereby made of the receipt during the past year of the following new varieties of fruits, vegetables, etc., for trial, viz:

STRAWBERRIES.

Banquet.—From J. R. Hawkins, of Mountainville, N. Y.

Howard's No 6.—From A. B. Howard, of Belchertown, Mass.

Lovett's Early.—
Shusler's Gem.— } From J. T. Lovett, of Little Silver, N. J.

BRIARS.

Jewett's Blackberry.—
Lovett's Black Cap.— } From J. T. Lovett, of Little Silver, N. J.

PEAR.

Wilder Pear Tree.—From Green's Nurseries, Rochester, N. Y.

GRAPES.

Green Mountain.—From Stephen Hoyt's Sons, of New Canaan, Conn.

White's Northern Muscat.—From the Ohio Culinary Grape Co., of Dayton, Ohio.

VEGETABLES.

<table>
<tr><td>All Head Cabbage.—</td><td rowspan="3">From W. A. Burpee, of Philadelphia, Penn.</td></tr>
<tr><td>New Cucumber, Sample X.—</td></tr>
<tr><td>Table Beet, Sample N.—</td></tr>
</table>

A collection of potatoes from the Horticultural Department of the Michigan Agricultural College.

A collection of potatoes from the Horticultural Department of the Vermont State Agricultural Experiment Station.

<table>
<tr><td>Monarch Ruta Baga Turnip.—</td><td rowspan="2">From Northrup, Braslau & Goodwin Co., of Minneapolis, Minn.</td></tr>
<tr><td>Yellow Imperial Carrot.—</td></tr>
</table>

<table>
<tr><td>Golden Crown Ruta Baga Turnip.—</td><td rowspan="2">From Delano Moore, of Presque Isle, Me.</td></tr>
<tr><td>Moore's Ruta Baga Turnip.—</td></tr>
</table>

GRASS.

Rescue Grass.—From the Department of Agriculture, Washington, D. C.

21

Willows for Osier Purposes.

Salix amygdalina canescens.	Received from the Forestry Division of the Department of Agriculture, Washington, D. C.
Salix amygdalina latifolia.	
Salix purpurea var. viminalis.	
Salix viminalis quene de renard.	
Salix viminalis red rough Galicia.	
Salix viminalis green rough Galicia.	
Salix viminalis (high growing, mixed).	
Salix viminalis Cinnamonea.	
Salix viminalis Alpecuroides.	
Salix viminalis Merriniana.	
Salix viminalis Stricta.	
Salix viminalis Sedanensis.	
Salix purpura Schutzeana.	

Apparatus.

Barnard's Monitor Moth and Insect Trap.—From W. C. Barnard, of Worcester, Mass.

Donations.

A collection of greenhouse plants and cuttings from James Nisbet, of Pawtucket, R. I.

A framed photograph of the original Buffum pear tree from Hon. Henry Bedlow, of Newport, R. I.

A glass case from Miss Mary F. Rose, of Kingston, R. I. (1889.)

An orange tree from Mrs. John H. Tifft, of Kingston, R. I. (1889.)

An orange tree from Miss Hannah Kenyon, of Kenyon, R. I.

A century plant (*Agave Americana*) from Mrs. John A. Barber, of Kingston, R. I.

METEOROLOGICAL RECORD.

L. F. KINNEY.

Meteorological observations are made at the Experiment Station daily, at 7 A. M., 2 P. M. and 9 P. M.

Table I. contains the daily, monthly and annual mean temperature at this Station for 1890.

Table II. contains the daily, monthly and annual rainfall at this Station for 1890.

Table III. contains the daily, monthly and annual atmospheric pressure, reduced to the sea level and a temperature of 32° F., at this Station for 1890.

TABLE I.—*Daily Mean Temperature for 1890.*

MONTHS.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
January	46.7	52.5	35.7	33.5	39.9	51.6	39.3	35.5	21.2	28.2	37.0	45.7	48.5	30.7	45.0	37.7	29.7
February	34.5	36.0	41.0	41.0	44.2	24.0	28.0	42.2	28.2	26.0	30.0	41.2	34.5	44.7	38.0	28.2	39.2
March	37.0	22.0	19.7	20.0	33.0	26.2	15.0	21.2	24.7	32.0	41.0	48.0	56.5	41.7	34.7	27.0	30.2
April	36.5	38.2	45.5	48.5	38.7	43.0	43.5	40.0	43.0	46.2	42.5	40.7	41.7	52.7	43.0	43.2	48.7
May	55.7	44.0	45.2	57.7	54.2	56.5	51.5	48.2	52.0	55.0	48.0	52.5	51.2	59.7	56.9	57.7	54.7
June	67.6	66.6	61.0	65.0	59.6	58.3	64.3	60.0	68.0	62.0	67.0	55.6	55.3	62.0	60.0	61.3	65.3
July	73.0	65.0	69.0	75.3	71.6	67.3	72.0	75.3	73.0	63.3	63.0	60.0	63.3	65.3	72.3	78.3	70.6
August	67.7	67.2	68.2	73.5	75.2	72.5	78.7	68.0	67.0	70.5	63.0	66.2	62.2	65.5	70.2	63.0	72.0
September	61.5	64.5	65.2	66.2	69.7	69.0	70.7	61.5	61.5	59.5	58.7	68.5	70.5	66.2	68.7	69.2	68.0
October	57.2	58.7	62.7	62.5	63.0	51.2	48.7	51.2	50.7	56.0	52.7	47.5	44.2	52.7	47.0	56.7	55.7
November	41.2	50.1	41.0	38.2	44.5	40.7	52.5	53.0	50.5	50.7	37.5	38.2	37.5	48.0	47.0	43.0	52.2
December	26.0	15.5	34.2	29.0	30.2	39.5	26.7	21.5	29.2	31.0	37.0	20.7	20.5	37.5	29.5	28.7	41.2

TABLE I.—*Daily Mean Temperature for 1890.*—Continued.

MONTH.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	Mean for Month.	Mean for Year.
January	32.5	42.0	42.0	41 0	13 7	24.2	23.2	32.7	38.7	32.0	26.2	44.5	34.2	36.0	36.4	....
February	31.5	32.2	25.7	14.7	22.5	42.7	43.2	42 7	47.2	42.5	40.5	....	....	....	35.2	....
March	37.5	27.5	35.5	44.7	41.2	34.0	32.0	32.7	48.0	39.0	34.2	32.7	37.0	36.5	33.5	....
April	39.0	40.2	43.2	51.0	50.0	52.7	58.7	39.2	42.7	48.0	46.2	44.7	51.0	....	44.7	....
May	54.5	61.7	54.7	51.0	53.0	58.2	54.7	55.0	54.5	57.5	54.5	54.2	53.7	62.5	54.1	....
June	71.0	72.0	60.0	57.0	61.6	63.0	65.1	70.3	73.3	68.3	69.6	65 6	67.3	....	63.9	....
July	69.0	59.0	59.6	62.0	66.6	65.0	69.3	70.3	73.6	73.6	71.0	74.3	72 3	79.0	69.1	....
August	67.7	67.0	67.5	63.2	70.2	67.5	55.0	62.2	68.0	70.5	66.5	66.5	62.7	56.5	66.9	....
September	64.7	64.7	63.5	54.2	61.0	60.7	49.7	48.0	60.7	59.5	49.0	48.5	41.5	....	61.4	....
October	52.1	55.2	44.7	42.5	41.0	44.2	48.2	43.0	42.2	47.5	38.7	46.2	43.7	38.7	49.8	....
November	50.8	43.0	32.5	38.0	38.7	30.0	35.5	48.2	31.2	38.0	21.2	33.5	38.5	....	41.3	....
December	30.5	17.2	24.2	39.5	33.5	39.7	24.2	15.7	29.0	27.7	12.0	20.7	15.7	18.5	27.3	48.7

TABLE II.—*Daily Rainfall, in inches and hundredths of an inch, for 1890.*

MONTH.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
January	....	....	....	....	0.10	0.05	....	0.05	....	0.13	0.20	....	....	....	1.11	0.40	...
February	....	0.02	0.05	0.05	0.03	....	...	1.04	....	0.05	....	....	....	0.55	....	....	....
March	0.33	0.35	0.85	....	T.	0.41	0.20	....	...	....	0.10	0.10	....	0.60	1.05	....	....
April	0.23	....	....	1.14	....	....	0.15	0.24	0.30	....	....	....	....	....	....	....	....
May	0.14	0.22	....	0.15	0.24	1.46	....	0.20	....	....	0.25	....	....	....	0.63	....	....
June	....	...	...	....	0.10	1.39	0.10	....	....	....	....	1.02	0.76	0.15	....	....	..
July	....	....	0.06	....	....	....	....	0.10	....	....	....	....	....	....	....	....	0.31
August	1.00	....	....	....	....	0.07	....	....	0.42	0.38	....	....	T.	....	....	....	....
September	....	....	....	...	0.15	0.40	...	...	....	....	0.19	0.10	0.52	T.	0.80	0.72	0.20
October	....	...	0.11	0.54	....	T.	0.52	0.22	....	0.02	0.08	....	....	0.52	0.24	...	1.30
November	....	....	....	....	....	....	....	....	....	....	....	0.40	....	....	0.22	....	....
December	....	....	0.82	....	....	0.25	...	....	....	....	....	....	....	....	....	....	....

TABLE II.—*Daily Rainfall, in inches and hundredths of an inch, for 1890.*—Continued.

MONTH.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	Total for Month.	Total for Year.
January	....	....	0.16	....	....	0.13	....	....	....	0.46	....	....	0.23	....	3.02	....
February	0.08	....	0.73	....	....	....	0.03	0.20	0.10	....	0.37	....	....	...	3.30	....
March	....	0.36	....	0.16	2.25	0.50	....	....	0.41	....	2.04	0.07	....	T.	9.83	....
April	....	....	....	....	....	....	0.24	0.02	0.90	1.45	0.07	....	....	....	4.74	....
May	....	....	0.58	....	....	....	...	....	0.15	0.68	....	....	....	....	4.70	....
June	....	....	....	0.06	0.40	...	...	T.	....	T.	....	....	....	....	3.98	....
July	....	0.22	....	....	....	....	....	0.60	....	....	0.45	0.14	....	....	1.88	....
August	0.08	0.10	0.16	....	....	0.10	....	...	....	1.58	....	....	....	....	3.89	....
September	....	....	.. .	....	....	...	....	....	0.78	0.07	....	....	....	....	3.93	..[illegible]....
October	....	0.97	0.18	....	....	T.	2.99	0.75	....	0.15	....	0.76	0.08	....	9.43	....
November	0.34	....	....	....	....	....	....	....	....	....	....	....	...	....	0.96	....
December	2.25	....	....	0.07	....	T.	....	....	2.12	....	....	....	....	T.	5.51	55.17 in.

TABLE III.—*Daily Mean Barometric Readings, reduced to the Sea Level and a Temperature of 32° F., for 1890.*

MONTH.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
January	30.60	30.28	30.40	30.57	30.05	29.67	29.92	29.57	29.85	29.98	30.14	29.91	29.80	30.24	30.03	29.71	30.41
February	30.32	30.41	29.89	30.03	29.54	30.20	30.51	29.59	30.26	30.58	30.45	30.07	30.13	29.84	29.66	30.22	29.98
March	29.83	29.89	29.97	30.18	29.95	30.07	30.14	30.27	30.37	30.45	30.27	30.26	30.14	29.99	29.72	29.51	29.56
April	30.26	30.44	30.21	29.72	29.90	30.20	29.83	29.69	29.57	29.60	29.98	30.33	29.97	29.84	30.16	30.19	29.97
May	29.98	30.15	30.13	29.93	29.72	29.70	29.98	29.99	29.09	29.94	30.09	30.11	29.94	29.79	29.87	29.96	29.96
June	29.90	30.00	30.14	30.01	30.00	29.97	29.84	30.21	30.18	30.21	29.94	29.97	29.88	29.92	30.14	30.27	30.12
July	29.95	29.98	29.90	29 83	29.93	30.07	30.04	29.88	29.80	30.01	30.18	30.15	30.10	30.12	30.32	30.07	29.94
August	30.03	30.12	30.04	30.01	30.03	Instrument out of order.											
September	30.15	30.23	30.21	30.21	30.13	30.00	30.08	30.19	30.16	30.29	30 25	30.00	30.04	30.08	30.09	29.95	29 72
October	30.27	30.25	29.83	29.88	29.87	29.83	29.90	29.98	30.26	30.06	29.89	29.93	30.02	29.78	29.87	30.02	29.51
November	29.78	29.68	29.65	29.86	30.12	30.12	30.11	30.05	30.08	30.08	30.19	30.14	29.96	30.04	30.09	30.15	29.72
December	29.59	30.07	30.01	29.84	30.21	30.06	30.02	30.15	29.80	29.53	29.59	29.70	29.16	29.97	30.22	30.39	29.80

TABLE III.—*Daily Mean Barometric Readings, reduced to the Sea Level and a Temperature of 32° F., for 1890.*—Continued.

MONTH.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	Mean for Month.	Mean for Year.
January	30.35	30.25	29.64	29.79	30.13	30.40	30.09	30.03	29.80	29.80	30.41	30.19	30.14	30.22	30.08	....
February	29.76	30.04	29.67	29.85	29.92	30.00	29.79	29.99	29.95	30.19	29.99	......	......	......	30.04	....
March	29.67	29.68	30.07	29.71	29.67	29.91	30.25	30.29	30.03	29.85	29.68	29.63	29.97	30.25	29.98	....
April	29.86	30.15	30.33	30.26	30.37	30.19	30.08	30.19	30.22	30.66	30.08	30.03	29.36	......	30.05	....
May	30.13	30.02	29.77	30.22	30.28	30.13	30.09	30.25	30.15	29.86	29.84	30.02	29.95	29.90	29.96	....
June	29.84	29.92	30.14	30.10	29.97	30.11	30.00	29.77	29.79	29.85	29.81	29.89	29.92	......	29.99	....
July	29.94	29.97	30.12	30.20	30.25	30.20	30.07	29.99	30.05	30.15	30.13	30.10	30.03	29.93	30.05	....
August	......	......	......	......	......	......	......	......	......	......	......	......	......	......	.....	(August excepted.)
September	29.95	29.99	30.04	30.15	30.06	29.89	30.13	30.26	30.05	30.03	30.24	30.30	30.21	......	30.10	....
October	29.87	29.69	29.68	30.02	30.28	30.18	29.37	29.64	29.62	29.46	29.53	29.45	29.63	29.96	29.82	....
November	29.52	29.52	29.58	29.89	29.78	29.76	30.03	29.72	29.95	29.88	29.86	29.85	29.62	......	29.80	....
December	29.45	30.10	30.52	29.95	29.93	29.72	30.04	30.49	29.98	29.36	29.80	29.83	30.34	30.26	29.98	29.99

APIARIAN DIVISION.

SAMUEL CUSHMAN.

The work of the season began about April 1st. Of the sixteen colonies of bees prepared for winter the previous fall, fourteen came through in good condition, and early in the season became very strong. The colonies that were packed in cork saw-dust on their summer stands were in much better condition than those wintered in the farm-house cellar. The record of the temperature of the cellar, however, shows that it stood below freezing much of the time, and therefore was an unsuitable place for wintering bees.

Owing to our non-residence, the time and trouble that would be regularly required to mix, and feed the bees each day with thin syrup to stimulate brood rearing—could not be given, therefore early in May each hive was supplied with a quantity of moist undissolved sugar. As this was gradually licked up by them it furnished a constant stimulus to brood rearing, and as our visits were made frequently enough to replenish the supply, the result was very satisfactory. For further particulars, see "Spring Report of the Apiarist," Bulletin No. 7.

An experiment in the rapid multiplication of colonies for quickly building up an Apiary from a few hives, was commenced and doubtless will be continued another season.

"The use of Artificial Heat to promote Brood Rearing" was tried with one hive, which was carefully compared with another that was under the same conditions and had the same strength. Though the results were quite satisfactory, this plan should be more carefully and extensively tried before it can be generally recommended. See Experiments in Apiculture, Bulletin No. 9. This line of work will probably be continued the coming season.

The test of imported Carniolan queens, as well as certain strains of American Italians, which was commenced in 1889, was continued the past season. For our conclusions in regard to Carniolans see Bulletin No. 9, page 108. Of the several strains of American Italians, a much advertised strain of yellow or "five banded" bees, which are very handsome, were found to equal or excel anything in the Apiary in producing extracted honey. They were, however, much more irritable than the average Italians, and, in our opinion, they have some Cyprian or Syrian blood, probably the former. One of these queens, bought in 1889, presided over the colony that occupied the scale hive. The brood of another colony was given them at the time they were placed on the scales. The record of the daily loss or gain was kept from June 6th to August 4th, and from August 13th to October 27th. It is given in Bulletin No. 9, to which the reader is referred for further particulars.

Other hives in the Apiary were used in the production of comb and extracted honey, in rearing queens, and to form small colonies in which to keep the queens until used. A number of young queens were sold to neighboring bee-keepers.

The honey crop, except that from three hives, was considerably restricted by the various experiments. The largest amount of comb honey that was secured from one colony was 42 pound boxes or sections. Of this all but a small per cent. was in the finest marketable shape. The comb honey was packed in small single tier cases, having one glass side, and holding 12 pound boxes.

The extracted honey was put up in tall, round, clear glass jars, having a screw cap, and was attractively labeled.* Before it was sold the whole crop was exhibited at the fairs. At the Kingston Fair this comb and extracted honey was shown, in addition to an exhibit of hives, bees, queens and supplies, which was similar to the one made the season previous.

The Station collection of the various hives used in different parts of the country was placed on exhibition at the State Fair, as well as a cage containing a swarm of bees, clustered and hanging from a limb, together with the season's crop of honey. Here our object was to supplement and aid the Rhode Island Bee-keepers exhibit, rather than to make a complete Apiary exhibit for the Station. The exhibit made by the Bee-keepers of the State, in completeness and in interesting features, has not been equalled at any fair in New England or in New York State.

After the removal of the summer's surplus crop, the colonies gathered considerable honey from fall flowers. This, added to the early honey that remained in the brood combs, gave an ample supply of winter stores for each, and some little surplus besides, therefore fall feeding was not necessary. Twenty colonies, each having an abundance of natural stores were prepared to winter on their summer stands. Sixteen hives were protected by a packing of cork saw-dust within an outer case or winter hive. Four were left in single walled hives, and were given no other protection than a chaff cushion in the surplus chamber.

The past season there has been an increase in the number of

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* For extracted honey we used two styles of jars. One is a tall, round jar, the glass of which is very clear and quite thin, while the screw cap has a cork lining and is nickel plated. These may be procured in several sizes of Dean, Foster & Co., of Boston and Chicago, or of Whiteall, Tatum & Co., of Boston and Philadelphia. The other style was of clear glass, but heavier, and the screw cap instead of being nickel plated was of polished tin. The caps of these were lined with wood parchment, and are made both with and without a wire bail attached to the cap. These were procured of the Excelsior Package Co., of 49 Warren street, New York City.

visits received from actual or intending bee-keepers, many of whom have spent several hours in the Apiary watching the Apiarist work among the bees. There has been, also, an increase in the number of letters that have been received asking for information relating to bee culture. A collection of all the principal books on bees or bee-keeping now published in America, England and Germany, as well as the bound volumes of the principal Bee Journals lately ordered, will give us an excellent reference and working library and increase our facilities for good work.

Early in the spring a circular was sent to forty-four Bee-keepers and postmasters in various parts of the State, in which they were requested to fill out blanks that were enclosed, with the names of all persons in their town and vicinity that kept bees. The responses, which were very prompt, furnished a list of 286 persons who then kept or had lately owned bees. Other names were added during the summer and fall, until the list contained 390 names. In January another circular was mailed to each address, in which the following questions were asked:

"How many colonies of bees did you have last spring?
How much surplus honey did you secure?
How many colonies had you at the commencement of winter?
What kind of hives are they in?
Of what variety are your bees?
Do you give them special protection in winter, and how?"

Responses were promptly received from nearly half of the circulars sent out. Of the 160 heard from, 150 had altogether 856 colonies.* There were 28 persons who kept ten or more colonies

* According to the returns of the State Census made in 1885 there were then in the State, 1,939 hives of bees. For a year or two after this, there was considerable growth in the interest in bee-keeping and a larger number of colonies were kept, but during the past few unfavorable seasons so many box hive colonies that were left to take care of themselves have died, that the number now owned probably does not exceed that of 1885. The number of modern hives in use is, however, much larger, and improved methods of management are much more generally understood and followed.

each. Of these, five persons had in movable frame hives more than 20 colonies each. One man had 50, another 30, and three, more than 20 colonies. Of these 28 bee-keepers, there were but two who still used, exclusively, the old box hive. Some had bees in both kinds of hives, and the remainder used only the modern frame hive. There were but four of the twenty-eight who kept only the black or so-called native bees. The apiaries of all the others contained some Italian blood, either pure or crossed.

A number reported that some years they had possessed from twenty to thirty colonies in box hives, but that the colonies had dwindled away and now they were without any. They had died from a lack of winter stores, the result of the late unfavorable seasons. A great number who had but one or two colonies in box hives had secured no surplus the past two years. Many using box hives reported that they "take up" or kill a few colonies when they wish to secure any honey. A few others have in the top of their box hives a crude arrangement in which some surplus comb honey is secured. The amount of surplus secured the past season had been either small or nothing, except where improved frame hives were used. Those reporting that they had secured any considerable amount of surplus, kept Italians or their crosses and used frame hives. Some complained that their bees stung them so viciously, when interfered with, that they had given up trying to do anything with them. The most vicious bees may be handled with the aid of a veil and a good smoker that gives volumes of smoke. By changing the queen for those of a gentle strain of Italians, this trouble will be overcome, and the honey crop will probably be increased. This operation can be done with the least trouble when the bees are gathering honey freely.

One person wrote that he thought of giving up bee-keeping because his neighbors complained that his bees ate his sound peaches while on the tree. In other States this question comes up oc-

casionally, but it has been demonstrated so many times that bees work on peaches only where soft spots first exist, or where they have been opened by other insects, that these facts are now very generally known. We request all who in the future may learn of a case where bees seem to be eating sound fruit, to inform us at once that we may investigate. Ripe fruit is a part of the bill of fare of wasps and certain other insects. What seems to be a real case of injury to fruit by bees almost always occurs during an abnormal season, when the wet weather causes fruit to crack or decay, and only when there is no honey in the fields that the bees may gather. Others, who gave their bees little care, had lost many colonies by moth worms. Moths usually act as scavengers. They destroy the combs, or use them and their contents for food. The colonies that dwindle away from other causes are the ones that fall a prey to the larvæ of the moth. Strong colonies will not be infested so long as they keep in good condition. Italians defend their hives from moths more vigorously than Black bees. One correspondent kept bees just to supply the market gardeners in his vicinity with colonies to use in green houses. Few used outer cases to protect the colonies in the winter. Many placed them south of a building or board fence. But one or two carried the bees into the cellar for the winter. A few of the best informed and most extensive bee-keepers used chaff hives or an outer winter case. Many who use a single walled frame hive gave no particular protection, except a cushion placed in the top of the hive.

Donations.

Chas. Dadant & Son, of Hamilton, Ill., have presented this division with a copy of their revision of "Langstroth on the Hive and the Honey Bee."

A lot of samples of glass jars and cans, suitable for marketing honey, milk, cream, butter, etc., has been received from the Excelsior Package Co., of 49 Warren street, New York City.

REPORT OF THE TREASURER.

The Rhode Island State Agricultural Experiment Station in account with the United States Appropriation.

Dr.

1890.	To receipts from Treasurer of the United States as per appropriation for year ending June 30, 1890, under Act of Congress approved March 2, 1887...........		$15,000 00

Cr.

June 30.	By Salaries.....	$3,887 28	
	Labor....................................	3,909 35	
	Supplies and repairs......................	1,091 91	
	Freight, express, postage and stationery..	594 52	
	Library and printing.....	613 93	
	Tools and machinery.......................	408 36	
	Scientific instruments......	19 20	
	Chemical apparatus and supplies..........	65 47	
	Furniture and general fittings...	1,627 11	
	Roads, water supply and drainage.... ...	1,396 65	
	Live stock................................	420 50	
	Traveling	149 34	
	Incidentals...........	115 77	
	Buildings................................	700 61	
		$15,000 00	$15,000 00

Melville Bull, Treasurer, in account with the United States Appropriation, under special Act of Congress passed April 4, 1890.

1890.			
May 24.	Cash from U. S. Treasurer............................		$15,000 00
June 30.	By cash on deposit.........................	$15,000 00	

We, the undersigned, duly appointed Auditors for the Board, do hereby certify that we have examined the books and accounts of the Agricultural Experiment Station of the Rhode Island State Agricultural School for the fiscal year ending June 30, 1890; that we have found the same well kept and correctly classified as above, and that the receipts for the time named are shown to have been $15,000.00, and that the corresponding disbursements, $15,000.00; for all of which proper vouchers are on file and have been examined by us and found correct, and that there is no unexpended balance.

CHARLES J. GREENE,
C. H. COGGESHALL,

Auditors for the Board of Managers of the Rhode Island State Agricultural School and Experiment Station.

I hereby certify that the above statement of account is a true copy from the books of the Institution named.

MELVILLE BULL,

Treasurer of the Rhode Island State Agricultural School and Experiment Station.

I hereby certify that the above signature is that of the Treasurer of the Rhode Island State Agricultural School and Experiment Station.

CHAS. O. FLAGG,

President of the Board of Managers of the Rhode Island State Agricultural School and Experiment Station.

Melville Bull, Treasurer, in account with the Rhode Island State Agricultural Experiment Station.

1890.			
June 30.	To receipts from farm		$112 66
"	" " for labor of men and teams on laboratory		811 00
"	" interest to date		91 03
			$1,014 69
June 30.	By furniture account	$30 92	
"	" cash to balance Experiment Station acct.	983 77	
		$1,014 69	$1,014 69

Melville Bull, Treasurer, in account with Laboratory Building Fund.

DR.

1889.			
Aug. 26.	Of State of Rhode Island	$1,200 00	
Oct. 25.	" " "	1,500 00	
Nov. 23.	" " "	1,500 00	
Dec. 10.	" " "	811 00	
1890.			
Jan. 3.	" " "	1,500 00	
Feb. 8.	" " "	2,500 00	
Apr. 30.	" " "	1,500 00	
July 7.	" " "	2,500 00	
Aug. 23.	" " "	989 00	
		$14,000 00	$14,000 00

CR.

1889.			
Aug. 26.	Paid W. W. Weeden	$200 00	
26.	" William Gosling	1,000 00	
Oct. 25.	" " "	1,500 00	
Nov. 23.	" " "	1,500 00	
Dec. 10.	" Experiment Station	811 00	
1890.			
Jan. 3.	" William Gosling	1,500 00	
Feb. 8.	" " "	2,500 00	
Apr. 30.	" " "	1,500 00	
July 7.	" " "	2,500 00	
Aug. 23.	" " "	989 00	
		$14,000 00	$14,000 00

We, the undersigned, duly appointed Auditors for the Board, do hereby certify that we have examined the books and accounts of the Agricultural Experiment Station of the Rhode Island State Agricultural School for the year ending June 30, 1890; that we have found the same well kept and correctly classified as above, and that proper vouchers are on file, have been examined by us and found correct.

CHARLES J. GREENE,
C. H. COGGESHALL.

INDEX

TO THE

ANNUAL REPORTS AND BULLETINS PUBLISHED BY THE R. I. STATE AGRICULTURAL SCHOOL AND EXPERIMENT STATION.

1889 TO 1891.

INDEX TO THE FIRST ANNUAL REPORT.

INDEX TO THE SECOND ANNUAL REPORT.

Part 1. State Agricultural School.

Part 2. State Agricultural Experiment Station.

INDEX TO BULLETIN NO. 6. MARCH, 1890.

Milk Fever or Parturient Apoplexy in Cows.

INDEX TO BULLETIN NO. 7. JUNE, 1890.

Catalogue of Fruits, Meteorological Summary, and Report of the Apiarist.

INDEX TO BULLETIN NO. 8. SEPTEMBER, 1890.

Soils and Fertilizers.

INDEX TO BULLETIN NO. 9. DECEMBER, 1890.

Experiments in Apiculture, Foul Brood, its Cause, Prevention and Cure.

Index to Third Annual Report.

Part 1. State Agricultural School.

INDEX TO THIRD ANNUAL REPORT, 1891.

Part 2. State Agricultural Experiment Station.

State of Rhode Island and Providence Plantations.

FOURTH ANNUAL REPORT

OF THE

BOARD OF MANAGERS

OF THE

Rhode Island State Agricultural School and Experiment Station,

MADE TO THE

GENERAL ASSEMBLY AT ITS JANUARY SESSION, 1892.

PART II.

Rhode Island

STATE AGRICULTURAL EXPERIMENT STATION,

[Part I – State Agricultural School—is printed under separate cover.]

PROVIDENCE:
E. L. FREEMAN & SON, STATE PRINTERS.
1892.

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F. E. RICE, M. D., M. R. C. V. S.,	Veterinarian.
J. D. TOWAR, B. Sc.,	Assistant Agriculturist.
B. L. HARTWELL, B. Sc.,	Assistant Chemist.
H. F. ADAMS,	Farmer.
MISS A. R. FRENCH,	Clerk.

The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office, Kingston, Rhode Island.

REPORT.

To His Excellency, Herbert W. Ladd, Governor, and the Honorable the General Assembly of the State of Rhode Island, at its January Session, 1892:

KINGSTON, Jan. 30th.

In conformity with the custom rendered necessary heretofore by the fact that the State Agricultural School was not established as a "Land Grant College," we publish this report in two parts. Part I applies to the work of the School and Part II to that of the Experiment Station.

At the beginning of the year just closed, our chemical laboratory had been ready for work but a few months, yet there seemed to be in the minds of some the idea that the analysis of all the fertilizers collected under the Fertilizer Inspection Law should be made by the Station, while the license fees imposed by the law upon the manufacturers should be a source of revenue to the State. This idea is erroneous for several reasons; first and chief of which is that the Congressional appropriation by which the Experiment Station is maintained is made for specific purposes, as outlined in the Hatch Act, (Bul. No. 1, page 6) and not to defray the expense of State fertilizer inspection. Aside from the text of the bill itself, this is evident when we consider that in some of the larger States more than the whole Congressional appropriation

would be required annually to defray the expense of the fertilizer inspection, and thus were the money so used the entire intent and purpose of the "Hatch Act" would be defeated. Again, nearly all laws providing for fertilizer inspection are based upon a license system which requires the manufacturer or dealer to pay a "license" or "analytical fee" for the privilege of selling his goods within the State, in accordance with certain conditions and restrictions. The amount of the license is based upon the *cost* of the inspection and is not assessed with any purpose of "revenue" to the State, but simply sufficient to protect the honest manufacturer and the consumer against the imposition of the dishonest manufacturer and dealer. This license, or the cost of inspection for the protection of their own trade and the fostering of the confidence of the consumers, the manufacturers and dealers are ready to pay. This tax, however, becomes eminently unjust when used by the State for *revenue*, as there is just as much propriety in taxing the cotton mill owner or the maker of machinery for such purposes, as the fertilizer manufacturer. As the fertilizer inspection in this State was by statute vested in the State Board of Agriculture, and it being the evident desire of the people that the analytical work of the inspection be done at the Experiment Station and the results published in bulletins as rapidly as possible, the Board of Managers on the 18th of February, 1891, made the following proposition to the State Board of Agriculture:

A PROPOSITION TO THE STATE BOARD OF AGRICULTURE.

"In consideration of the fact that in a majority of the States the analysis of fertilizers under the fertilizer inspection is made at the agricultural experiment stations, and bulletins containing the results of the same are periodically issued therefrom, and in accordance with such general usage and to further the interests of

the farmers of Rhode Island, the Board of Managers of the State Agricultural School and Experiment Station hereby make the following proposition to the State Board of Agriculture:

1. To analyze all samples of commercial fertilizers and wood ashes collected in accordance with the provisions of an act for regulating the sale of the same in this State, lately introduced in the General Assembly. The work to be done in the laboratory of the Rhode Island State Agricultural Experiment Station under the direction of the Station chemist.

2. The chemist to compile all analyses in accordance with the provisions of said act, and the said Agricultural Experiment Station to publish and issue to all persons whose names are on the Station mailing list or who shall request them, the results of the same in connection with the Station Bulletins as rapidly as the collection of the samples and the progress of the work will allow. And, furthermore, to furnish a complete copy of the results of said analyses so compiled to the State Board of Agriculture for publication in their annual report.

Since the Experiment Station is wholly maintained by the United States appropriation under the "Hatch Act," given for specific purposes, and in no sense by the funds of the State, the Board of Managers would expect the State Board of Agriculture to pay from the license fees collected under the provisions of the said act for the control of the sale of commercial fertilizers, only the cost of the time of a competent assistant required in making the analyses and of the necessary chemicals."

This proposition was accepted by the State Board of Agriculture April 8th, 1891, and the work of collection immediately began. The Board was fortunate in securing as assistant chemist B. L. Hartwell, B. Sc., whose two years service in the State Experiment Station in Massachusetts especially fitted him for the work in hand. Owing to the delay caused by the effort to secure the passage of a

more efficient fertilizer law, the inspection began very late and consequently the analyses could not be completed and published as early in the season as is desirable. This will doubtless be remedied as soon as the present law is replaced by one embodying all the features experience has shown desirable.

The Board of Managers had, previous to the opening of the year, discussed the advisability of inaugurating a line of experimental work for the benefit of the poultry interests of the State and the large number of people interested to a greater or less extent in some phase of the poultry business. The State census of 1885 places the value of our poultry *live stock* at $240,742.00, and the eggs produced (used and sold) 1,767,340 dozen, valued at $390,694, or 162.2 per cent. of the poultry valuation; the total sales of poultry were $167.009, equal to 69.3 per cent. of the poultry valuation, while the value of poultry manure is given as $32,555, or 13.5 per cent. of the valuation, making a total annual *gross* value of poultry products of $590,258, or 245 per cent. upon the value of the poultry classed as "Live Stock" and 8.19 per cent. of the total value of *all* the *agricultural* products ($7,204,642) in the State in 1885. This is sufficient to show the relative magnitude of the poultry industry in this State. With the importance of the work fully in mind, the Board voted on February 12th to establish a Poultry Division, and arranged with the Apiarist of the Station, Mr. Samuel Cushman, to take charge of the work. Considerable experience in the raising of thoroughbred fowls qualified him for the enterprise. Some time has been devoted to visiting the best poultry raisers in the country and obtaining as far as possible all the modern ideas in regard to poultry houses, incubators, brooders, caponizing, the raising of broilers, etc., which we hope to make of value to the poultry raisers of the State, through the medium of bulletins in the near future. A good general idea of what has been done in a practical way, thus far, is given in the report of Mr. Cushman, herewith submitted.

During 1890, pending the construction of the Laboratory, the Chemist of the Station had charge of the co-operative field experiments and in other ways materially assisted the Director in his work, but the Laboratory completed, the chemical work required his entire time. This together with the increasing labor connected with the field and plot experimental work, made it necessary to employ an assistant in the agricultural work, and a graduate of the Michigan Agricultural College, J. D. Towar, B. Sc., was secured as Assistant Agriculturist. The superintending of the co-operative field experiments and the keeping of the records in the field and plot work of the Station have been a part of his duty during the year.

The hay barn on the plain has been moved about 100 feet to the north, near the line of the new highway, and raised about eighteen inches and underpinned with rubble wall in cement. A scale pit was dug in the floorway and a set of Fairbanks hay scales four ton size, with double beams; one graduated to avoirdupois scale and one to metric scale, set up for use in the weighing of crops.

A large amount of time of men and teams has been required to grade the grounds about the buildings, remove the stone, lay drains, construct roads and walks and make other necessary improvements, all of a permanent nature.

A pure bred Holstein cow and calf have been added to the live stock of the Station and some additions made to the machinery and tools.

A fairly complete working library has been provided for each of the Station divisions and some general reference books.

Five bulletins have been published during the year, as follows: No. 10, May, pages 123–130, by Dr. F. E. Rice, Veterinarian. Contents: 1. Mixed Foods in cases of Faulty Appetite in Horses and Neat Stock, including notice of patented and proprietary foods. II. Sore Shoulders in Horses.

No. 11, June, pages 130–148, Dr. H. J. Wheeler, Chemist. Contents: I. The State Fertilizer Law as it is and as it might be. II. Commercial Values of Fertilizer Stock. III. Analyses of Commercial Fertilizers, State Inspection, 1891. IV. Analyses Miscellaneous Materials sent on for examination. V. Meteorological Summary by Prof. L. F. Kinney.

No. 12, August, pages 148–158, Dr. H. J. Wheeler, Chemist. Contents: Further Analyses of Commercial Fertilizers collected under the State Inspection, 1891, with comments.

No. 13, September, pages 158–172, Dr. H. J. Wheeler, Chemist. Contents: Concluded List of Fertilizer Analyses, State Inspection, 1891. Analyses of Miscellaneous Materials.

No. 14, October, pages 172–190, L. F. Kinney, B. Sc., Horticulturist. Contents: Notes on the Potato Scab. Notes on the Bordeaux mixture as a preventative of the Potato Scab. Notes on the Bordeaux mixture as a preventative of the Potato Blight Notes on Transplanting Onions.

Four thousand copies of each bulletin have been printed and comparatively few are still on hand to meet the future call for back numbers, and the demand is constantly increasing.

The Station needs in the very near future, for efficient work, a good stock barn, conveniently arranged for a dairy and with wings suitably equipped for experimental feeding of stock. A good silo should be included, as well as storage room for hay and grain. A good practical dairy room is necessary for illustration and instruction in dairy work. An equally urgent requirement is a good green house for the use of the Horticultural Division. The present structure is of a temporary nature, cheaply constructed by roofing with hot bed sash and using a "Johnson car heater" for a boiler. A moderate sized greenhouse constructed and heated in accordance with modern practice will be of service in experimental work requiring fixed condition of temperature, soil, etc., and prove of material assistance in the work of that Division.

On the 20th of February, after a brief illness, Dr. James H. Eldredge died in the seventy-fifth year of his age. Dr. Eldredge was appointed one of the Board of Managers in May, 1890, as the representative of Kent County for the term of five years. Although attending the meetings of the Board for less than a year, Dr. Eldredge ever manifested an earnest interest in the affairs of the institution and by a regular attendance upon the meetings of the Board gave material assistance in the organization of the School. The Board at a meeting held March 6th ordered spread upon its records resolutions expressing an appreciation of his sterling integrity as a man, constant faithfulness in every line of duty as a citizen and uniform courtesy and genial kindness as a friend and associate. What higher tribute can be paid to man than that in his native town and lifelong home he held the love and esteem of his fellow men ?

The vacancy in the Board caused by the death of Dr. Eldredge was filled by the appointment of Hon. Nathan D. Pierce, Jr., of Norwood for the unexpired term.

The Board have held twenty-one meetings during the year.

We have the pleasure of transmitting herewith the reports of the Director, Chemist, Horticulturist, Apiarist and Poultry Manager, Veterinarian, Meteorological Report and Financial Report of the Treasurer, all of which is

Respectfully submitted,

CHAS. O. FLAGG,

President of the Board of Managers.

REPORT OF THE DIRECTOR

CHAS O. FLAGG.

The work of the Station the past year has been encouraging in each division. With the passage of time comes a better condition of soil and circumstances and a more complete equipment for satisfactory work. It is to be expected that some work will prove of little practical value when the attempt is made to demonstrate theories, but out of failures valuable lessons are often learned which prove stepping stones to ultimate success.

The weather is an unavoidable condition which always influences the success or failure of agricultural operations, therefore in this connection, we will make a brief comparison of the records taken at this Station. The mean temperature varied but slightly from that of the previous years, the yearly average of 1891 being 48.9° and in 1890, 48.7°. The first three months averaged 2.9° colder. May was 1° colder and July 4.5° colder than corresponding months of 1890, while the mean temperature in August was 2.4° higher and in September 2.9° higher than the mean of 1890. There was little difference in the two following months, but December was very mild compared to the weather of the year previous, the mercury recording a mean 12.2° *higher* than in 1890.

The total rainfall for the year was 49.64 inches, or 5.53 inches *less* than the total rainfall of 1890, as taken at this Station. The following table gives the mean temperature and the total fall of rain and melted snow for each month since our meteorological division was established.

MEAN TEMPERATURE.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Average.
1889......	......	......	......	45.9	56.6	64.49	67.7	66.1	61.5	49.2	43.5	38.4	.....
1890......	36.4	35.2	33.5	44.7	54.1	63.9	69.1	66.9	61.4	49.8	41.3	27.3	48.63
1891........	31.5	32.1	32.8	44.9	53.1	63.6	65.6	69.3	64.3	49.7	40.3	39.5	48.92

TOTAL RAIN FALL AND MELTED SNOW.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Average.
1889	......	......	......	4.20	3.58	3.66	3.30	4.57	4.61	3.02	7.52	2.76	......
1890........	3.02	3.30	9.83	4.74	4.70	3.98	1.88	3.89	3.93	9.43	.96	5.51	4.59
1891........	7.31	7.26	7.97	4.70	1.76	.70	2.11	2.69	2.20	6.22	2.99	3.73	4.136

More than twice as much rain fell in January and February as in the same time the previous year, over seven inches each month. Nearly eight inches fell in March, less, however, than in 1890, when the unusual quantity of 9.83 inches fell. In April the rain fall varied but little from previous records, but May was the beginning of a drouth which was quite severe in June, when only seven-tenths of an inch of rain fell, as against 3.98 and 3.66 inches in previous years and *less* than an *average* quantity of rain fell each month until October. For five months following May 1st the total rainfall was 9.46 inches, as compared with 18.4 for a corresponding time in 1890. The remaining three months of 1891 12.94 inches of rain and snow fell, or 2.36 inches *less* than in 1890. During the first three months of the year the precipitation was 22.54 inches, 45.4 per cent. of the rainfall of the year. The total number of days in which one-tenth of an inch or more of rain fell was 83, the greatest number in any one month being 10

in August and the same in December. The least number was 3 in June. In 1890, upon the same basis of calculation, 120 days were rainy, there being 16 days each in March and October, and the least number in any one month was 3 in November. In nine months in 1889, beginning with the beginning of our record, April 1st, 90 days were rainy, and for the corresponding time in 1890 there were 80 rainy days, and in the past year 63 rainy days. Thus while the rainfall was less than usual and very unequally distributed, doubtless causing injury to the hay crop, early potatoes, berries and early garden crops, the comparatively small number of rainy days gave excellent opportunity to secure the hay crop in fine condition. The oat crop was especially good this season and remarkably free from "rust," (a fungus growth known by botanists as *Puccinia Coronata*, (Cda.) most abundant upon the leaves) while in 1890 the crop was exceptionally poor, owing to the large amount of "rust." It is quite possible that the greater amount of rainfall in May and June, in 1890, may have caused the widespread appearance of the "oat rust." The fall months had few rainy days and the weather was fine for curing the corn crop and securing the fodder in good condition, a subject to which more attention can profitably be given by all stock owners. The mild weather of the late fall and the unfrozen condition of the soil late in December made it possible to do considerable work in the line of permanent improvements about the farm before winter fairly set in.

AGRICULTURAL DIVISION.

The following is a summary of the experimental work undertaken this season by the Agricultural Division:

(1) The coöperative field experiments were continued in nine different towns of the State and a corresponding field upon the Station grounds in charge of J. D. Towar, B. Sc., Assistant Agriculturist.

(2) The application of ashes to grass land in winter and in spring.

(3) The growing of rye upon the corn fertilizer plots.

(4) Field fertilizer test with oats, including drill and broadcast sowing.

(5) Tests of varieties of oats, barley, wheat, sorghum, beets, &c.

(6) Experiment in relation to the prevention of smut in oats.

(7) Field fertilizer experiments with corn.

(8) Comparison of varieties of corn.

Permanent Experiment Plots. Much has been said upon the value of plot experiments, some investigators claiming that results so obtained are not reliable data for field work, and others claiming that there is no more practical way of securing natural conditions and approximate field results than by well conducted plot experiments. The first great difficulty is met in the *uneven* quality of any large area of ground. A field which at first sight appears perfectly level, or of perfectly even quality, is found to contain little depressions in which water collects, and as it settles away a little sediment is deposited, and, gradually, the soil just there grows deeper and richer, while at some point a little higher the soil is constantly growing thinner. Artificial causes, such as old fence rows, boundaries of former fields, places where manure has been piled or hay stacked, or, perhaps, where piles of logs or brush have at some former time been burned, so affect the soil that crops grown upon such spots for many years afterward will show an increase over the balance of the field. This makes the selection of any large area for permanent plot work where crops, varieties of seeds, fertilizers or methods of cultivation are to be tested by *comparison of results*, exceedingly difficult. Variation in subsoil, which is beyond the reach of the eye and more difficult to examine minutely than the surface soil, will also often cause wide variation in results. These difficulties can only be met by

cropping the ground one, two or more years without any fertilizers whatever, making careful records of the results, and if any plots show evident marks of unusual stores of plant food, due record can be made of the fact and such plots omitted in making comparative tests. Another objection made by some is that the *outside rows* of a field have more air, sunlight, and, if the adjacent ground is cultivated, perhaps more feeding ground, than the inner rows of the same field, and in a small plot there is a far larger relative proportion of *outside* to *inside* rows than in ordinary field culture, so that a calculation of "per acre" yields from plots gives results that are larger than practical acre trials would yield. The only way to overcome this objection is to make the plots each a little larger than the area designed for calculation, so that a certain amount of the outside of the crop upon the plot is cut away before the "plot" proper is reached. This makes a plot *within* a plot, and manure is applied at a uniform rate over the whole surface of the *larger* plot and the whole planted and cultivated as intended in the experiment. This arrangement practically gives the crop *interior field* conditions as regards light, moisture, fertilizer, feeding ground and air. Considerable more space is occupied by a certain number of plots laid out in this way than in the ordinary way, and more fertilizers, seeds, cultivation and care in harvesting the crops is required, but the advantages are believed to be sufficient to warrant the laying out of our permanent experiment plots in this way. The field selected is the southerly half of the middle portion of the plain, is a light sandy loam and nearly level. A small quantity of fine hay was cut from the whole field in '89 and immediately after haying that part of the field occupied by plots 1 to 16 was plowed 6 inches deep and sown with Hungarian grass, receiving at the same time a light dressing of ground bone, drilled in with the seed. Dry weather prevented an early germination of the seed and only a partial crop resulted. In the spring

of '90 about six cords per acre of stable manure (from horses) was applied broadcast, the ground plowed, harrowed and Hungarian again sown. A moderate crop was harvested. After haying the remainder of the field was broken up to the depth of the agricultural soil, about 5 or 6 inches, and remained unharrowed until spring, when the plots were laid out in accordance with the accompanying plan. The plots are in two parallel rows, separated by a roadway 20 feet in width. Each plot is 193.6 feet in length by 30 feet in width and contains 2-15 of an acre. The inner plot is 181.5 feet in length and 24 feet in width and contains 1-10 of an acre, making the difference just 1-30 of an acre, a convenience in calculating results. The width of the plots is such that in growing corn or potatoes planted in rows or drills 3 feet apart, there will be 10 rows upon a plot and 8 upon the inner plot, making a row upon each side and two rows (6 feet) upon each end *to reject* in harvesting the tenth-acre plots. The space between the plots is 3 feet in width, which will be just filled by one row if it is desirable to crop the *entire surface.*

In continuing experiments covering a series of years, it is important to have the boundaries of the plots so marked that no change will be likely to occur in plowing or in any other way, in short, to be permanent, and so prominent as to be easily distinguished and yet not interfere with horse cultivation. To meet these requirements all the corners of plots Nos. 1 and 2 and the east corners of all the other plots have been marked in the following way: Pieces of two-inch gas pipe, two feet in length, have been driven into the soil in a perpendicular position, leaving only about one inch above the surface. Gas pipe one and one half inches in diameter is cut into pieces four feet long; one foot from one end a hole is drilled and a three-eights inch iron pin driven through so that it projects about one-fourth of an inch upon each side of the gas pipe. These pieces are then painted white and one placed

in each of the pipes driven into the ground, the pin keeping them all at the same height above the surface (3 feet) to present an even appearance. When plowing or cultivating one is easily slipped out of the socket and as quickly replaced when the team has passed. Plans are being made and perfected for a course of experiments upon these forty plots which shall cover a series of years that *average* data may be secured upon which to base conclusions. Results attained by an experiment in one season may be entirely different another season owing to different climatic conditions beyond the control of the experimenter, hence the average of the results of several seasons is only to be relied upon as conclusive.

Farm Crops. The supervision of the labor of the farm, care of teams, stock, etc., has been satisfactorily performed, as heretofore, by Mr. H. F. Adams. Altogether during the season about fifty acres of ground has been plowed. This includes some ten acres of rocky pasture, around and to the east of the school buildings, a portion of which has been seeded in lawns and the remainder will be cultivated until cleared from brush.

The hay crop was very light, owing to the dry weather in June, the newly seeded field at the west of the plain yielding less than one ton per acre. The remainder of the west plain field was sown to rye and seeded with grass and other fields will be seeded as rapidly as possible, that a sufficient quantity of good hay for our stock may be produced on the farm.

The grain and fodder crops were as follows: 130 bushels oats, 37 bushels rye, 220 baskets sound corn, 6 tons corn stover, 3 tons oat straw, 2 tons rye straw, 4 tons Hungarian, 14 tons hay, 100 bushels carrots, and 1½ acres of corn fodder fed to the stock during the fall and early winter. The above does not include two acres of garden crops and potatoes grown for school use nor the crops of the Horticultural Division. Considerable time of the farm teams and men has been required in grading around the new

school buildings, and in breaking up the rough pasture land extending east of College Hall. To provide for the proper conveyance of surface water, two large stone catch basins were constructed in the two natural depressions upon either side of College Hall and east of the buildings, and large stone culverts laid to convey the water to the sewer. The laying of these drains provided a means of clearing the land about the buildings from stone and also furnished earth needed in grading. A small stone arched bridge was put in late in the fall where the road to the Veterinary Hospital will cross the "Run" northeast of the Laboratory.

During the spring a double row of Austrian pines was set upon the north and west sides of the Apiary and one row of Austrian pines and two rows of Larches upon the west side of the poultry yard. Some willows were set upon the southwest of the poultry yard and a few along the north boundary of the farm. Although the weather following the setting was very dry, by mulching the ground and thoroughly watering the trees once or twice, nearly all lived and are making satisfactory growth.

The Farm Stock. A registered Holstein cow, "Fabiola 3rd," (No. 7631) and heifer calf (since registered as "Fabiola Lady," No. 28,324) were purchased of H. E. Tabor in April. This cow, with two native or grade cows and a grade Guernsey heifer, have furnished milk for the farmer and the boarding house during the year. A pure bred Jersey bull, "Experiment," a pure bred Ayrshire bull, "Geneva Boy" (No. 4975) and a pure bred Ayrshire heifer (No. 11,050) constitute the balance of the neat stock aside from teams. Two pairs of oxen and four horses have been required to perform the team work. Ten pigs have been kept a portion of the year.

The School Garden. About three acres of ground west of the school buildings was set aside early in the spring for the school garden, and while in charge of the Director and his Assistant

most of the manual labor, from plowing the ground to harvesting the crops, has been performed by the students. An abundant supply of fresh vegetables of nearly all kinds for summer use in the boarding house, and potatoes, beets, onions, etc., for a winter supply were produced. Five hundred Cuthbert raspberry plants, 300 Snyder blackberry plants and 1600 strawberry plants were set out to provide a supply of fruit in the future. The work gave excellent opportunity for teaching by precept and example the importance of a good garden and methods necessary to secure it.

Chemical Division. The fitting up of a laboratory with every thing needful in the way of chemicals and appliances for perfect analytical work requires a little time, and it was not until this year that much could be done. As narrated elsewhere the chemical work of the State inspection of fertilizers has been conducted here and the results published in bulletins and issued to the farmers of the State. Another season we trust the various delays incident to this year's work will be overcome, the work completed and the fertilizer bulletins placed before the public at an earlier date. Many inquiries of a chemical nature come to the Station and are referred to the Chemist for advice. A far larger number of materials have been received for examination than heretofore, all of which indicates an increasing interest in the work of the Station and a desire for information on the part of the people of the State.

Horticultural Division. With the progress of each year comes a better condition of soil for garden and experiment work, giving a better opportunity for studying trials of varieties and seedlings as well as more gratifying results from old and well tried sorts of fruits and vegetables. A portion of the experimental work of the season may be found in bulletin No. 14 and the report of the Horticulturist published herewith. A botanical garden, including a small pond for aquatic plants for the purpose of illustration and

instruction, has been laid out just east of the bridge constructed for the road to the Veterinary Hospital. The temporary greenhouse was partly reconstructed last autumn, making it more convenient and better fitted for the work in hand than before, but one of the pressing requirements of this Division is a commodious, durable greenhouse, constructed with a view to the necessities of the work and the most modern ideas of heating, ventilating, etc. Connected with the greenhouse or near by should be a building containing a work room for use of the division and good cellar storage room for the keeping of roots, bulbs, plants, potatoes and fruit. With such conveniences this Division would be equipped to do much better work in the line of horticulture.

Apiary. The bees are an interesting subject to many who visit the Station. The results this season have been quite satisfactory, as may be seen by the report of the head of this division. We fully believe that the influence bees and insects exert in the proper fertilization of the flowers of fruits and vegetables is of far greater importance than is generally allowed. Aside from this great benefit of which we can form no just estimate, we have the honey stored by the busy bee for our profit. The care required is not great and the profit of keeping a few bees is often considerable in proportion to the outlay.

Poultry Division. This is a Division organized during the year, but one we believe is to result in benefit to a large class of our citizens. Every farm has its poultry, quite often cared for by the wife or children of the farmer, and a source of revenue to them, but farther than this, very many members of our large industrial population who live in factory villages and around our cities keep "a few hens," and often in this class one finds an ardent admirer of some pure breed. We believe the work so well begun this season will in time teach some truths and lead to profitable results.

Veterinary Division. The hospital being in an unfinished condition, nothing has been done in the way of the practical treatment of sick or diseased animals upon the farm, other than to attend to the needs of the animals belonging to the Station. The completion of the hospital in the near future is desirable. Quite a number of calls have been made upon the Veterinarian for advice in regard to sick or lame horses and cattle, and for this reason the office has been supplied with a limited quantity of drugs and medicines for use in such cases. A reasonable price is charged to cover the expense of the same. In connection with the State Board of Agriculture, the Veterinarian was made the final referee in cases of tuberculosis and was called upon in that capacity to visit several herds.

Field Day. To give the farmers of the State a good opportunity to visit the Station, the use of the grove at the west end of the farm bordering Laurel Lake was tendered to the R. I. State Grange for a "Field Day," which proposition was accepted and the picnic occurred August 12th. Excursion trains stopped a short distance from the grove and through the courtesy of Messrs. Sweet and Adams, neighboring land owners, but a short walk was necessary to reach the grove. The day was pleasant, although very warm, and the roads very dusty, but some fifteen hundred people visited the Station. The Wakefield Cornet Band furnished music and a number of speakers addressed the gathering during the afternoon. Although the dining accommodations were unsatisfactory for so large a party, the first "Field Day" at this Station reflected much credit upon the Grange in the matter of attendance and interest, and we trust the future may hold in store more of these valuable and pleasant social gatherings.

Fairs. Exhibits of grains, potatoes, onions, etc., illustrating the results of experimental work at the Station, were made at both the Washington County Fair at West Kingston and the State Fair

at Narragansett Park. A poultry exhibit was made at both the above fairs and also the Woonsocket Fair and the R. I. Poultry Show in Providence, designed to illustrate the results of "caponizing." While the exhibiting at these fairs (without competing for premiums) involves some expense to the Station, and requires considerable time upon the part of the heads of Divisions, it is believed that the fairs afford an opportunity of illustrating the results attained as cannot otherwise be done.

A list of the books, pamphlets, periodicals, papers and other donations to the Station is appended to this report and we desire to express our thanks for the receipt of the same. We also desire to acknowledge the interest and faithfulness with which the heads of Divisions and assistants have performed their duties, also our indebtedness to those who have conducted the co-operative plot experiments as set forth in the report upon that subject, for the care and labor involved in the experiments. To the public we are indebted for much encouragement and often suggestions which are of value. We believe the greatest benefit can only result from the most intimate relation between the people and the Station, its work and workers. We are glad to record an increasing number of visitors during the year.

FIELD AND PLOT EXPERIMENTS.

CHAS. O. FLAGG. J. D. TOWAR.

Comparison of winter and spring applications of ashes to newly seeded meadow. A portion of the old sheep pasture at the west end of the plain was plowed and seeded with a mixture of Timothy and Redtop in September, 1890. It is a light, sandy loam soil and it was determined to fertilize the piece with Canada ashes during the winter and to determine whether any loss resulted from washing, while the ground was frozen. The following test was made: The ashes were hauled directly from the car and spread from the cart upon the field when the ground was frozen and covered with four inches of snow. The field is very level and two plots of 1-5 acre each were selected and staked out side by side. Upon the west plot, on January 6th, 1-2 ton of ashes was spread upon the snow as early as possible, and a corresponding 1-2 ton of ashes placed in barrels in a dry storehouse for application to the plot in the spring. The spring application was made April 10th, the ground at this time being free from frost but soft from the spring rains, and to prevent cutting up the field the ashes had to be applied by hand from baskets. This increased cost of labor, coming at a time of year when farm work of all kinds is especially pressing, is a serious disadvantage. The very dry weather of May and June shortened the crop very materially, but the grass was cut July 10th, and the weight of well cured hay upon the two plots determined as follows: West plot, yield of field cured hay per acre from winter application, 1906 pounds. East plot, yield of field cured hay per acre from spring application, 1497 pounds, showing a gain of 409 pounds per acre or 27 per cent. in favor of the winter application, to which can well be added the economy of labor in doing the work while the ground is frozen and other work is not pressing.

Rye crop following the two years fertilizer experiment with

corn. The plots of land at the westerly end of the plain where the fertilizer experiment with corn was conducted during 1889 and 1890, were plowed in the fall of 1890 and, without any further application of fertilizers, were sown to rye. Below we give a table showing the kinds and amounts of fertilizers applied in 1889 and 1890, also the yield of the rye crop harvested in 1891. The reader may be interested in studying the following table in connection with the former tables given on pages 19 and 20 of the Third Annual Report of this Station.

FERTILIZER EXPERIMENTS WITH RYE.

	Fertilizer applied per acre.				Yield per acre. 1891.	
	Kind.	1889.	Kind.	1890.	Grain.	Straw.
		Lbs.		Lbs.	Bush.	Lbs.
7	Bone Black	320	Bone Black	180	2.91	381
8	Muriate of Potash	160	Muriate of Potash	110	00.00	0000
9	Stable Manure	6 cd.	Stable Manure	6 cd.	14.40	1829
10	Nothing		Nothing		00.00	0000
11	Seaweed	10 cd.	Nothing		1.34	170
12	Sulphate of Potash	160	Sulphate of Potash	200	00.00	0000
13	Bone Black	320	Bone Black	180		
	Ground Bone	400	Ground Bone	400	8.26	1225
14	Muriate of Potash	160	Muriate of Potash	110		
	Ground Bone	400	Ground Bone	400	11.65	1259
15	Stable Manure	6 cd.	Stable Manure	6 cd.		
	Ground Bone	400	Ground Bone	400	21.88	2477
16	Ground Bone	400	Ground Bone	400	11.30	1218
17	Seaweed	10 cd.				
	Ground Bone	400	Ground Bone	400	12.64	1525
18	Sulphate of Potash	160	Sulphate of Potash	200		
	Ground Bone	400	Ground Bone	400	7.43	1082
20	Muriate of Potash	160	Muriate of Potash	110		
	Bone Black	320				
	Sulphate of Ammonia	160	Nitrate of Soda	160	00.00	0000
21	Stable Manure	6 cd.	Stable Manure	6 cd.		
	Muriate of Potash	160	Muriate of Potash	110		
	Sulphate of Ammonia	160	Nitrate of Soda	160	24.06	3117
22	Muriate of Potash	160	Muriate of Potash	110		
	Sulphate of Ammonia	160	Nitrate of Soda	160	1.70	476
23	Seaweed	10 cd.				
	Muriate of Potash	160	Muriate of Potash	110		
	Sulphate of Ammonia	160	Nitrate of Soda	160	2.55	538
24	Sulphate of Potash	160	Sulphate of Potash	100		
	Muriate of Potash	160	Muriate of Potash	110		
	Sulphate of Ammonia	160	Nitrate of Soda	160	00.00	0000

Referring to the above table, we have a good illustration of the real condition of the soil. The plots on which no fertilizer was applied have produced comparatively nothing, and those on which only nitrogen and potash in the most soluble form have been applied, such as nitrate of soda, sulphate of ammonia, muriate and sulphate of potash, have produced little or no rye. Noticing the plots on which ground bone was applied and considering its cheapness we find that we have a fair crop of rye for the money expended. Phosphoric acid applied in the form of bone black did not give such lasting benefits to the soil as when applied in the form of ground bone, but upon examination of the table showing results of the first application in 1889, we find bone black to have produced the better yield.

It will be noticed that the sea weed applied on plots 11 and 23 in 1889 have become nearly exhausted, while the same may be said of plot 17, since with its sea weed in 1889, in addition to ground bone in 1889 and 1890, it has produced only 1.34 bushels more rye than plot 16, which received the same amount of ground bone without the sea weed.

The rye crop from plots 15 and 21 tells us that nitrogen and potash added to stable manure made a better fertilizer for the rye crop than a combination of stable manure and phosphoric acid, while the reverse proved true with the corn crop.

We repeat the conclusions drawn one year ago. "*It is evident that this soil is very deficient in phosphoric acid and that unless that element is supplied the expenditure of money for other fertilizing elements is a positive waste.*"

1890 Oat Experiment Continued. The ground on which the oat experiment of 1890 was conducted as described on pages 15 to 17 of the Third Annual Report of this Station was again sown to oats in the spring of 1891. Sea weed at the rate of 9.14 cords per acre was applied, being spread from the wagon as it was

hauled, costing $4 per cord or $36.56 per acre. April 7th the ground was plowed to a depth of 6 inches with a Syracuse sulky plow. April 8th the field was divided into north and south halves, the former sown broadcast and the latter drilled with an Empire grain drill. York State white oats were sown, 3 bushels per acre in each case. The ground where the oats were sown broadcast was harrowed once before and twice after the oats were sown. When the oats were drilled the ground was harrowed twice and then drilled. The following table shows the amount and cost of fertilizers used in 1890 and 1891 as well as the yields of grain and straw in 1891.

TABLE SHOWING THE KIND, AMOUNT AND COST OF FERTILIZER IN 1890 AND 1891; ALSO THE YIELD OF OATS AND STRAW IN 1891.

	FERTILIZERS USED. 1890.	COST PER ACRE. 1890.	COST PER ACRE. 1891.	How Sown.	Yield per Acre, 1891. Bush. of Grain.	Yield per Acre, 1891. Lbs. of Straw.
1	935 lbs. Earle's Horsefoot		Seaweed at	*D.	51.4	3022
	Guano	$14.02	the rate of	B.	55.5	3961
2	935 lbs. Earle's Horsefoot		9.14 cords	D.	56.7	2831
	Guano	14.02	per acre at	B.	60.0	3797
3	935 lbs. Earle's Horsefoot		$4 per cord	D.	56.3	2831
	Guano	14.02	= $36.56.	B.	62.5	4254
4	935 lbs. Earle's Horsefoot			D.	54.4	2193
	Guano	14.02		B.	63.4	3131
5	Nothing			D.	60.0	3478
	"			B.	68.9	3839
6	Nothing			D.	47.7	2069
	"			B.	51.8	3553
7	†877 lbs. Mixed Chemicals			D	53 7	2940
	" "	14.02		B.	49.6	2001
8	†877 lbs. Mixed Chemicals			D.	48.1	2600
	" "	14.02		B.	41.8	1743
9	†877 lbs. Mixed Chemicals			D.	52.7	2974
	" "	14.02		B.	46.6	2110

*D.—Drilled. B.—Broadcast.

† Mixed chemicals contained 74 lbs. muriate of potash, 100 lbs. nitrate of soda, 403 lbs of dissolved bone, 100 lbs. fine ground bone, 100 lbs. tankage and 100 lbs. sulphate of ammonia.

4

From the above table we find that the average of the Earle's Horsefoot Guano plots, 1, 2, 3 and 4, was 57.5 bushels per acre, of plots 5 and 6 (nothing 1890, seaweed 1891) the average yield was 57.1 bushels per acre, while where the mixed chemicals were applied, plots 7, 8 and 9, the average yield was 45.4 bushels per acre, thus showing that neither the mixed chemicals nor the Horsefoot guano applied in 1890 seemed to benefit the crop in 1891.

A little of the seaweed was hauled in September and spread upon plots 7, 8 and 9, where the oats were sown broadcast, also upon plot 1, where the oats were drilled. The seaweed was applied to the remainder of the field during the winter and spring. It will be seen by the table of yields that where the seaweed was applied in September, the yield was much lighter than upon other portions of the field, apparently indicating a loss through exposure upon the surface for so long a time.

This experiment will be continued another year to determine the lasting qualities of the seaweed and whether the guano or chemicals will give any apparent gain in the crop.

Drill versus Broadcast Seeding. The experiment with the two methods of sowing was tried one year ago and repeated this year, dividing every plot; sowing the north half broadcast and the south half with an Empire Grain drill, using the same amount of seed in each case.

The broadcast oats came up first and gave a little better appearance all through the growing season, but at harvest showed an increase over the drilled oats of only 37 pounds per acre.

VARIETY TESTS.

Oats. Twenty-eight varieties of oats were sown on plots 6 x 8 feet. Two ounces of seed were used on each plot (about 3 1-2 bushels per acre) and one pound of good fertilizer applied. The oats all came up, grew and ripened quite uniformly. American Welcome, Early Blossom, Pringle's Progress, Swedish and Har-

gett's White were ready to cut August 6th. The remaining white varieties were ripe August 11, while the black oats, Black Etampes, Joanette Black and Chennailles Black were not ripe until August 15th, Chennailles Black being a little earlier than the other two. The seed marked O. A. C. was donated by the Ontario Agricultural College in 1889. We shall test on a larger scale the best ten varieties the coming season, with a view to introduce and distribute some of the most promising kinds among the farmers of the State. The following gives the results:

OATS.

Name of Variety.	Where Obtained.	Nativity.	Yield per Acre.	
			Grain.	Straw.
Bavarian	O. A. C.	Canada	70.9 Bush.	4198 Lbs.
Chennailles Black	"	France	69.1 "	3119 "
Rosedale	"	Canada	65.6 "	3460 "
Russian			63.8 "	2950 "
Improved American			62.9 "	3290 "
Michigan Clipped			60.2 "	3176 "
New York State			58.5 "	3232 "
Vermont	Seed Store.		58.5 "	2893 "
Joanette Black	O. A. C.	France	58.5 "	2893 "
Legonia	"	Russia	55.0 "	2666 "
Improved Besthorn	"	Germany	51.4 "	2983 "
York State White			49.6 "	3063 "
White Abundance	O. A. C.	France	49.6 "	2269 "
Early Blossom	"	England	47.8 "	2893 "
Probsteier	"	Germany	46.1 "	2485 "
Siberian	"	Russia	40.7 "	2666 "
Oderbrücher	"	Germany	40.7 "	1985 "
Georgian White	"	Germany	39.0 "	2836 "
Danebrog	"	Germany	39.0 "	2382 "
Pringle's Progress	"	Canada	39.0 "	2269 "
Swedish	Seed Store.		35.6 "	3176 "
White Tartarian	O. A. C.	Russia	35.6 "	2722 "
Hargett's White			35.6 "	2722 "
Banner	O. A. C.	Canada	30.1 "	2212 "
American Welcome	"	Germany	21.3 "	3062 "
Black Etampes	"	France	19.5 "	1872 "
Flying Scotchman	"	England	11.8 "	1531 "

Barley. Twenty-two varieties of barley were sown on 6 x 8 feet plots, using 2 ounces of seed and 1 pound of good fertilizer.

The yields were not very satisfactory, as will be seen by the following table. Those marked O. A. C. were donated in 1889 by the Ontario Agricultural College.

BARLEY.

Name of Variety.	Where Obtained.	Nativity.	Yield per Acre.	
			Grain.	Straw.
*Guymalaya	O. A. C.	Sweden		
Phœnix	"	Germany	18.9 Bush.	1362 Lbs.
6 Rowed	"	Canada	15.9 "	935 "
Chevalier	"	Canada	14.8 "	1106 "
Probsteier	"	Germany	13.8 "	1616 "
Cape			10.0 "	652 "
Barley on Wheat Row			9.5 "	907 "
Empress	O. A. C.	England	8.3 "	964 "
Australian	"	Germany	7.1 "	737 "
Melon	Washington.	Russia	4.7 "	454 "
Maudschurei	O. A. C.	Russia	4.7 "	340 "
Improved Golden Melon	"	England	4.1 "	539 "
Chevalier	"	New Zealand	3.5 "	340 "
Italian Rice	"	Germany	3.5 "	283 "

* Guymalaya produced a good crop (apparently the best of all) but as a part of it was used for exhibition and was not threshed, we omit the yield.

The following varieties were given the same chance as the above, but their yields were too light to be worth calculating: Golden Drop, Spreading or Fan, Peerless White, Early Black, Hallett's Pedigree, Cheyne, Kalina and Skinless.

The earliest varieties, Phœnix, 6 Rowed, Chevalier (Canada), Probsteier, Cape, Italian, Rice, Maudschurei and Barley on Wheat Row were ripe and cut July 29. The remaining varieties were not ripe until August 6. It is our plan to test the best five or six varieties another year.

Wheat. In the fall of 1890, 6 varieties of wheat were received from the Rural New Yorker and 11 from Carter's London. They were sown but all winter killed. Thinking that they might possibly have been spring varieties, we sowed more of the same April 30th, resulting in failure to mature.

Twenty spring varieties were sown April 30th, with the following results:

Name of Variety.	Where Obtained.	Nativity.	Yield per Acre.	
			Grain.	Straw.
White Russian.	O. A. C.	Canada.	10.40 Bush.	1588 Lbs.
Red Fyfe.	"	"	5.67 "	907 "
Campbell's White Chaff.	Steele Bros.	.	5.20 "	1049 "
Colorado.	O. A. C.	Canada.	5.20 "	936 "
Green Mountain.	"	"	5.20 "	909 "
Red Fern.	"	"	5.20 "	709 "
White Fyfe.	"	"	4.72 "	624 "
Ladoga.	"	"	4.25 "	482 "
Dantzic.	"	Russia.	2.84 "	737 "
Triumph.	"	"	2.36 "	652 "

The following varieties, the most of which are foreign, were tried beside the above but they were almost total failures. King Bartigen, Medeah, Wild Goose, Spelz, Herison Bearded, Black Trimenia, Sorentino, Poland, Holben's Improved and Pringle's Champion. It would seem from the above light yields that our Rhode Island plain lands cannot grow wheat with profit. It might be added that the soils on which grains, oats and wheat were grown was rather light and not what would be selected for good wheat and barley land.

Sorghum. The seeds from eleven different heads of sorghum, sent from the Department of Agriculture, Washington, were planted June 10th and liberally fertilized. The sorghum made a fair growth but not sufficient to warrant us in making a chemical study of its sugar value.

Sugar Beets. The following five varieties of sugar beets, the seed of which was received from the Department of Agriculture, Washington, were sown May 2d.* Balteau Desprez Richest, Flor-

* The soil on which the beets were sown was a light sand and had not lately been plowed deeper than six inches. The seed, too, was one year old.

imond Desprez Richest, Simon Le Grand, Dippe's Valmorin and Dippe's Kleinwanzleben.

Only two varieties attained sufficient growth for analysis. Balteau Desprez Richest and Florimond Desprez Richest contained 13.39 and 13.56 per cent. cane sugar respectively.

Flax, Hemp, etc. An attempt to grow a small quantity of flax met with fair success. It grew to the height of 18 inches and the heads were fairly well filled with seeds. Our trial with hemp proved a failure, as did also Pearl Millet, probably owing to the age of the seeds, as hardly a stalk appeared upon the plots. The Pearl Millett sown was from the same sample sown in 1889 and which then produced a rank crop of fodder from 5 to 7 or more feet in height. Its chief disadvantage as a fodder crop is its rather slow and feeble growth after germinating, until well rooted, when its growth is rapid. It requires a warm, mellow seed bed for best results. Fresh seed should be used.

A few seeds of Jerusalem corn were planted, resulting in a fair growth, as did also the Kansas King corn. The latter grew to a good height, producing very large, juicy stalks. We believe this corn would prove profitable to use in soiling and making ensilage. It was not planted until May 28th, but reached the height of 10 feet, with ears well developed, though not mature.

Smut of Oats. The "*Jensen hot water treatment*" of oats for the prevention of smut was tested as follows: Six varieties were selected and two 2 ounce lots of seed of each variety were weighed out. Before sowing, one lot of each variety was immersed in water at from 133° to 135° for five minutes. The other was sown untreated. The varieties of oats selected for the experiment were White Bonanza, York State, Early Blossom, Russian, New York State and Vermont. White Bonanza was used unthreshed to exhibit at the fairs and its yield was not computed. The remaining five varieties were threshed with the following results:

NAME OF VARIETY.	UNTREATED.		TREATED.	
	Bush. of Grain per Acre.	Pounds of Straw per Acre.	Bush. of Grain per Acre.	Pounds of Straw per Acre.
York State	49.6	3063	67.3	3289
Early Blossom	47.8	2893	65.6	3176
Russian	63.8	2950	62.2	3119
New York State	58.5	3232	56.7	3009
Vermont	58.5	2893	67.3	3743
Total	278.2	15031	319.1	16333
Average	55.64	3006	63.82	3266
Gain in favor of Treated Oats			8.18	260

From the above we find that the treated oats show a gain in yield of grain of 8.18 bushels per acre or 14.7 per cent.; and a gain of 260 pounds of straw or 8.6 per cent. There was in the *New York State* treated plot one stalk of smut. It is possible that this variety was not immersed long enough in the hot water to completely destroy the smut spores. The untreated oats contained 3 to 4 per cent. of smutted heads. The gain in the crop through treating the seed is much greater than would be the case were the 3 to 4 per cent. of smutted heads replaced with sound ones. Whether there may be a partial development of smut in some plants sufficient to dwarf them and lessen the yield without being manifest to the eye as smut or whether the hot water treatment in some unexplained way gives increased vigor to the plants besides destroying the smut is not apparent. Similar results have been attained elsewhere. We quote from Prof. W. A. Kellerman: * "The yield of oats when treated with hot water * * * to prevent smut is increased, not simply by an amount which equals the portion destroyed by smut, but by at least twice that amount." A bulletin, No. 15, to be issued April, 1892, will contain directions for treating the seed and further information in regard to oat smut.

Fertilizer experiment with corn. A piece of land west of the

* Bulletin No. 22, page 81, Experiment Station of the Kansas State Agricultural College.

field used for the twentieth acre plots was plowed soon after haying in the season of 1890. The soil is a light sandy loam, too thin in quality to produce any crop without liberal fertilizing. An acre at the east end of the field was manured with 12 1-10 cords of stable manure, costing $78.50. It was determined to test 1-4 acre plots with fertilizers in comparison with the stable manure. Six plots of 1-4 acre each were laid off, care being taken to select only such portions of the field as presented soil of an even quality, rejecting such portions as contained even shallow hollows, on account of the soil being deeper there through the effect of "washing." The stable manure was hauled to the field and spread during the last of December. The entire field was plowed to the depth of about 6 inches by April 24th. Where manure was applied the land was fitted for planting by harrowing and cross harrowing with the Acme and Thomas smoothing harrows, April 28 and 29. Where fertilizers or chemicals were applied the furrows were smoothed down and the fertilizer applied by hand broadcast and harrowed in by working each plot separately, twice over, with the smoothing harrow. The field was marked for planting in rows three feet apart each way, using a marker constructed for the purpose as follows: Seven common round iron window weights, six pound size, were purchased, a light pole about 23 feet in length, a piece of board 1 1-2 or 2 inches wide and 19 feet in length, and seven pieces of stout cord, each about 7 feet in length, were procured Mark the pole at points exactly three feet apart, beginning 6 inches from one end, (screw eyes may be inserted) and fasten a cord at each such point, except the last. Bore seven holes large enough to pass the cord through the strip of board at points three feet apart; pass the cords through the holes and to each one fasten a window weight. The board will keep the weights evenly spread and prevent any rolling in marking over rough ground. Two men use the marker, one carrying each end

of the pole. If care is taken to make the first line straight and the man at the end where there is no weight, in returning carefully follows the last mark made, a large field can be marked very quickly and accurately, as each trip across the field marks seven rows. The men should keep *abreast* of each other to do perfect marking. The corn is quickly planted in the checks by the use of an "automatic" hand corn planter, dropping four to six kernels in the hill, 1 1-2 to 2 inches deep. The germination and growth of the corn showed plainly that the harrowing given was *insufficient* to thoroughly incorporate with the soil the amount of fertilizer and chemicals applied. The yield where the larger amounts of mixed chemicals were applied was *decreased* by the failure of the seed to germinate, replanting causing an undue proportion of soft corn, and the dwarfing of the crop as a whole through the excessive quantity of chemicals insufficiently incorporated with the soil.

The number of missing hills which were replanted June 16, and the yield of soft corn upon each plot was as follows:

Plot No.	Missing Hills.	Yield of Soft Corn in lbs. per Plot.
1	13	40
2	56	65
3	294	126
4	136	107
5	19	107
6	204	124

The cultivating was done with a "Planet, Jr." or "Iron Age" cultivator and was intended to be shallow, keeping the surface mellow and free from weeds. The field was cultivated June 5, July 28, and hand hoed June 9 to 13, and July 21.

The corn was cut up and shocked September 21–24, and husked and weighed October 26 to November 2. The weather was very

fine and the stover was dry and in good condition for storing in the barn or stacking. The following table gives the results:

No. of Plot.	KIND OF FERTILIZER.	Amount of Fertilizer per Acre.	Cost of Fertilizer per Acre.	Yield of Corn per Acre—1 bush. = 70 lbs. of Corn on the Cob. Hard. Bush.	Hard. Value at 75c per Bush.	Soft. Bush.	Soft. Value at 37½c per Bush.	Yield of Stover per Acre. Lbs.	Value at $7 per Ton.	Total Value per acre.
1	Barnyard Manure................	12 cds..	$78 50	$74 66	$56 00	2.31	$0 87	4020	$14 07	$70 94
2	Commercial Fertilizer............	4572 lbs.	78 50	61 30	45 98	3.88	1 46	4812	16 84	64 29
3	Dissolved Bone Black............	1750 "								
	Nitrate of Soda..................	1500 "								
	Muriate of Potash................	650 "	78 50	28 06	21 05	9.6	3 60	2728	9 54	34 20
4	Same as No. 3, ½ Ration.........		39 25	31 54	23 66	6.91	2 59	2121	8 47	34 72
5	Same as No. 3, ¼ Ration.........		19 63	35 43	26 57	6.21	2 33	2346	8 21	37 11
6	Ground Bone.......	675 lbs.								
	Nitrate of Soda..................	184 "								
	Muriate of Potash................	246 "	21 00	21 26	15 95	8.63	3 24	1968	6 89	26 08

Test of varieties of corn. White Capped and Lackawaxen, two varieties of white flint corn, were grown on 1-4 acre plots under similar treatment. The 1-4 acre of white capped corn was plot No. 1 in the fertilizer experiment, and the Lackawaxen was planted upon 1-4 of the same acre, fertilized with the same quantity and quality of stable manure and the land prepared in the same manner and planted May 23. The following are the results:

NAME OF VARIETY.	Bush. per Acre. Hard Corn.	Bush. per Acre. Soft Corn.	Tons of Stover per Acre.	Value of Crop per Acre. Hard Corn 75c per Bush.	Soft Corn 37½c per Bush.	Stover. $7 per Ton.	Total.
White Capped...... ...	74.66	2.31	2.01	$55 69	$0 87	$14 07	$70 90
Lackawaxen...........	65.54	7.70	2.23	49 15	2 89	15 61	67 65

November 5th, 50 pounds of each variety on the cob was hung in bags in the crib to determine the amount of shrinkage of each during the winter. This result will be published in a later report.

CO-OPERATIVE FIELD EXPERIMENTS WITH FERTILIZERS, ON INDIAN CORN.

J. D. TOWAR.

The plan adopted for the co-operative field experiments for the season of 1890, and carried out by Dr. H. J. Wheeler as published in the report of the Experiment Station work of that year, was continued during 1891 in a like manner, with the same amount and kind of fertilizers and, as far as possible, on the same ground.

We were obliged to discontinue the experiment at Nayatt Point and substitute a plot of ground near Newport, under charge of Hon. Melville Bull. It was deemed advisable to change the location of the experiment acre on Mr. Tefft's farm to one of higher ground, as the field used last year was too wet. The experiment at the south end of Jamestown was discontinued. On the remaining eight fields the experiment was repeated the same as one year ago.

As will be seen by the accompanying plan, the arrangement of the plots was exactly the same as in 1890.

PLAN OF EXPERIMENTAL FIELDS.

Showing the arrangements of plots and the kind and amount of fertilizers applied. Twenty plots, each plot one-twentieth of an acre. Where possible unmanured strips were left between the plots.

0. No Manure.

1. Nitrate of Soda, 7.5 lbs.

2. Dissolved Bone Black, 17.5 lbs.

3. Muriate of Potash, 6.5 lbs.

4. Nitrate of Soda, 7.5 lbs.; Dissolved Bone Black, 17.5 lbs.

5. Nitrate of Soda, 7.5 lbs.; Muriate of Potash, 6.5 lbs.

6. Dissolved Bone Black, 17.5 lbs.; Muriate of Potash, 6.5 lbs.; "Mixed Minerals."

7. Mixed Minerals as No. 6, plus Nitrate of Soda, 7.5 lbs., ⅓ Ration.

8. Mixed Minerals as No. 6, plus Nitrate of Soda, 15 lbs., ⅔ Ration.

9. Mixed Minerals as No. 6, plus Nitrate of Soda, 22.5 lbs., full Ration.

6*a*. Mixed Minerals. Duplicate of No. 6.

10. Mixed Minerals as No. 6, plus Sulphate of Ammonia, 5.8 lbs., ⅓ Ration.

11. Mixed Minerals as No. 6, plus Sulphate of Ammonia, 11.6 lbs., ⅔ Ration.

12. Mixed Minerals as No. 6, plus Sulphate of Ammonia, 17.4 lbs., full Ration.

6*b*. Mixed Minerals. Duplicate of No. 6.

13. Mixed Minerals as No. 6, plus Dried Blood, 11 lbs., ⅓ Ration.

14. Mixed Minerals as No. 6, plus Dried Blood, 22 lbs., ⅔ Ration.

15. Mixed Minerals as No. 6, plus Dried Blood, 33 lbs., full Ration.

6*c*. Mixed Minerals as No. 6. Duplicate of No. 6.

00. No Manure.

Our fertilizing materials cost us on board the cars at Pawtucket as follows:

Nitrate of Soda	$48 00	per ton.
Sulphate of Ammonia	74 00	"
Dried Blood	35 00	"
Muriate of Potash	47 00	"
Dissolved Boneblack	25 00	"

At the above prices, and according to the following analyses of these materials by our Station chemists, nitrogen cost,

In the form of nitrate of soda	$15.81	per pound.
" " " ammoniates	18.45	" "
" " " organic nitrogen (blood, after allowing the value of phosphoric acid at 6 cents per pound)	15.18	" "
Potash (potassium oxide) cost	4.18	" "
Phosphoric acid	8.13	" "

ANALYSES OF FERTILIZING MATERIALS USED IN THE CO-OPERATIVE FIELD EXPERIMENTS.

Nitrogen.

Sulphate of Ammonia	20.05	per cent.
Nitrate of Soda	15.18	"
Dried Blood	10.26	"

Potassium Oxide.

Muriate of Potash	56.20	per cent.

Phosphoric Acid.

Dissolved Bone-black, Soluble	14.98	per cent.
" " Reverted	.38	"
" " Insoluble	.13	"
" " Total	15.49	"
Dried Blood, "	3.21	"

Some changes were necessitated in the amount of fertilizers used. The muriate of potash was a little stronger in actual potash, so the amount per plot was reduced to 6½ pounds. The dissolved bone-black applied this year was found to contain less phosphoric acid than last year, though this fact not having been learned before the material was used, the same amount of bone as before was applied. The quantity of sulphate of ammonia used was increased a little. The dried blood used contained 3.21 per cent. of phosphoric acid, thus furnishing the dried blood plots with a greater supply of phosphoric acid than any of the other plots in the experiment.

The following are the tabulated amounts of each element applied per acre, according to the analyses made at our laboratory :

TABLE SHOWING THE WEIGHT AND COST OF FERTILIZERS.

No. of Plot.	Weight per Plot.	Kind of Fertilizer.	Weight per Acre.	Nitrogen per Acre.	Actual Potash per Acre.	Total Phosphoric Acid per Acre.	Cost delivered on the cars at Pawtucket, per Acre.
	lbs.		lbs.	lbs.	lbs.	lbs.	
0.	0.0	Nothing...	......		......	......	......
1	7 5	Nitrate of Soda...	150	22 8	...		$3 60
2.	17.5	Dissolved Bone-black ...	350		..	54.2	4 38
3.	6.5	Muriate of Potash...	130	....	73.1		3 06
4.	7.5 17 5	Nitrate of Soda... 150 Dissolved Bone-black ... 350	500	22.8	....	54.2	7 98
5.	7.5 6 5	Nitrate of Soda ... 150 Muriate of Potash... 130	280	22 8	73 1	..	6 66
6.	17.5 6.5	Dissolved Bone-black .... Muriate of Potash ... Mixed Minerals, 350 130	480	....	73 1	54.2	7 44
		Nitrate of Soda Group.					
7.	24.0 7.5	Mixed Minerals as No. 6 ... 480 Nitrate of Soda, ⅓ Ration ... 150	630	22 8	73.1	54.2	11 04
8	24.0 15.0	Mixed Minerals as No. 6 ... 480 Nitrate of Soda, ⅔ Ration... 300	780	45 6	73 1	54.2	14 64
9.	24.0 22.5	Mixed Minerals as No. 6 ... 480 Nitrate of Soda, full Ration... 450	930	68.4	73.1	54.2	18 24
6a.	24 0	Mixed Minerals as No. 6 ...	480	..	73 1	54.2	7 44
		Sulphate of Ammonia Group.					
10	24 0 5 8	Mixed Minerals as No. 6... 480 Sulph. of Ammonia, ⅓ Ration... 116	596	23.3	73 1	54.2	11 73
11.	24 0 11.6	Mixed Minerals as No 6 ... 480 Sulph. of Ammonia, ⅔ Ration... 232	712	46.6	73 1	54.2	16 02
12.	24 0 17.4	Mixed Minerals as No. 6... 480 Sulph. of Ammonia, full Ration 348	828	69 9	73.1	54.2	20 31
6b	24.0	Mixed Minerals as No. 6...	480	...	73.1	54.2	7 44
		Dried Blood Group.					
13	24 0 11 0	Mixed Minerals as No. 6 ... 480 Dried Blood, ⅓ Ration ... 220	700	22.6	73 1	61.3	11 29
14	24 0 22.0	Mixed Minerals as No. 6 ... 480 Dried Blood, ⅔ Ration ... 440	920	45.2	73 1	68.3	15 14
15	24 0 33 0	Mixed Minerals as No. 6... 480 Dried Blood, full Ration ... 660	1140	67.8	73.1	75.4	18 99
6c	24.0	Mixed Minerals as No. 6...	480	...	73.1	54 2	7 44
00	0.0	Nothing. ...	....	....	...	....	.....

Special care was exercised in working the ground·preparatory to planting the crop, so as not to mix the soil of one plot with that of its neighbor. The ground was plowed, harrowed and cultivated lengthwise of the plots, and the fertilizers applied broadcast and harrowed in.

As the descriptions of the soils and the objects of the experiments were so completely given in the report of last year, those matters will be either omitted in the following report or quoted from that of last year, to which the reader's attention is also invited for general information and comparison.

The following are the objects of the experiment, three of which are in substance the same as last year: 1. To determine which of the three elements of plant food (nitrogen, phosphoric acid, or potash) are the most lacking. 2. For testing the relative fertilizing value of nitrogen in the various nitrogenous compounds, such as nitrate of soda, sulphate of ammonia, and dried blood. 3. To learn something if possible, of the probable profit or loss from large and small applications of nitrogen to the Indian corn crop. 4. To determine in what respects the results of this year's experiments verify the conclusions of last year.

DETAILS OF THE INDIVIDUAL EXPERIMENTS.

KINGSTON, R. I.

1. The Experiment Station Experiment.

"The land selected for this experiment was located on the plain on the westerly portion of the farm. The area had been in grass for many years and had become partially overgrown with moss, producing hardly enough grass to pay for the cutting. The soil to a depth of from four and a half to five inches consisted of a sandy loam underlaid by yellow loam and subsoil of alternating layers of coarse sand and gravel."

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

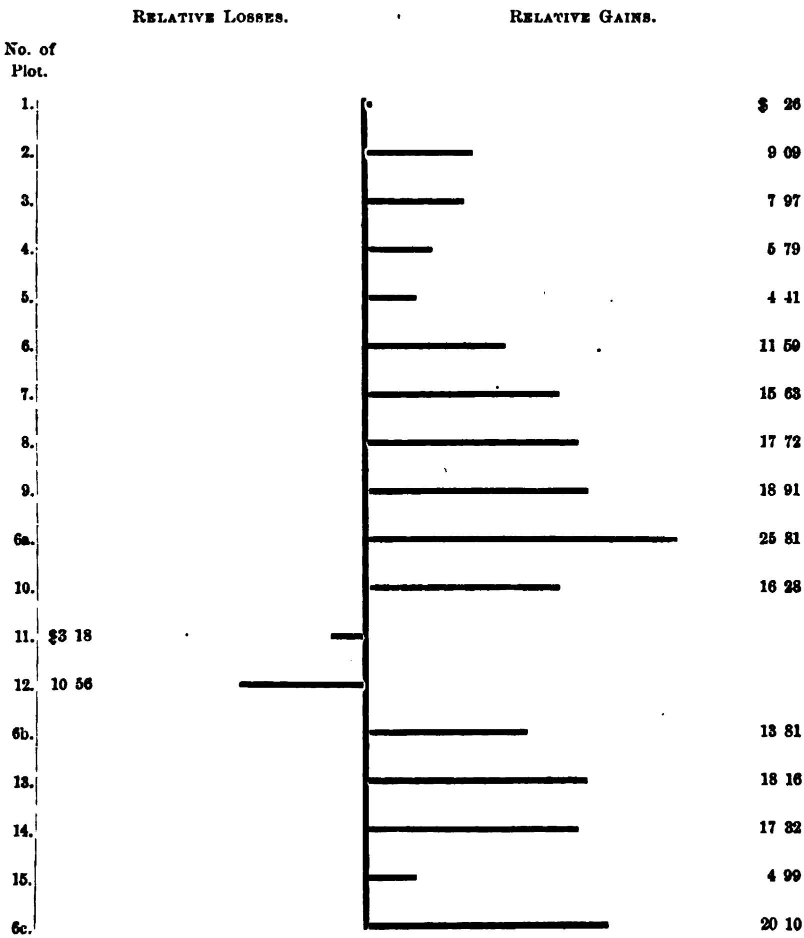
No. of Plot.	Kind of Fertilizer.	Total yield per Plot.			Total yield per Acre.		
		Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	11.50	7.75	25.75	3.28	2.21	515
1	Nitrate of Soda	19.50	11.75	28.75	5.57	3.35	575
2.	Dissolved Bone-black	50.25	20.75	58.00	14.35	5.93	1160
3.	Muriate of Potash	45.25	15.00	47.25	12.93	4 28	945
4.	Nitrate of Soda, Dissolved Bone-black,	45.50	27.50	66 50	13.00	7.85	1330
5.	Nitrate of Soda, Muriate of Potash,	42.75	16.50	53.25	12.21	4 71	1065
6.	Dissolved Bone-black, Muriate of Potash... Mixed Minerals.	77.00	12.25	68 50	22.00	3.50	1370
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ¼ Ration,	107 50	12.00	84.75	30.71	3.43	1695
8.	Mixed Minerals as No. 6, Nitrate of Soda, ½ Ration,	131.00	6.75	102 00	37.43	1.93	2040
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration	143.75	9.00	128.00	41.07	2.57	2560
6a.	Mixed Minerals as No. 6	134.50	5.25	106 25	38.43	1.50	2125
	Sulphate of Ammonia Group.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ¼ Ration,	114.75	5.25	92 00	32.78	1 50	1840
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ½ Ration,	54.25	7.50	57 00	15.50	2.14	1140
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Rat'n,	44.75	8.00	41.25	12.78	2.28	825
6b.	Mixed Minerals as No. 6.	91.50	6.50	64 75	26.14	1.85	1295
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ¼ Ration,	119.25	5.50	98 25	34.07	1 57	1965
14.	Mixed Minerals as No. 6, Dried Blood, ½ Ration	135.75	3.00	94 75	38.78	.85	1895
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	96.50	11.75	80.50	27.57	3.35	1610
6c.	Mixed Minerals as No. 6	112.00	8.25	89.00	32.00	2 35	1780
00	Nothing	4.15	3.10	12.00	1.18	.88	240

TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Stover.	Stover.	Total value per acre of the corn and stover over that of the "nothing" plots.	Cost of Fertilizer per Acre.	Value of the Crop per Acre over the cost of the Fertilizer. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 37½c. per bush.	lbs.	Value at $7 per ton.			
1.	3.34	$2.50	1 80	$0.67	197	$0 69	$3 86	$3 60	$0 26
2.	12.12	9.09	4.38	1.64	782	2.74	13.47	4.38	9.09
3.	10.70	8.02	2.73	1.02	571	1.99	11.03	3.06	7.97
4.	10.77	8.08	6.30	2.36	952	3.33	13.77	7.98	5 79
5.	9.98	7.48	3.16	1.18	687	2.41	11 07	6.66	4 41
6.	19.77	14 83	1 95	.73	992	3 47	19.03	7.44	11.59
7.	28.48	21.36	1 88	.70	1317	4 61	26.67	11 04	15.63
8.	35.20	26.40	.38	.14	1662	5.82	32.36	14.64	17.72
9.	38.84	29.13	1 02	.38	2182	7 64	37.15	18.24	18 91
6a.	36.20	27 15	—.05	—.02	1757	6.12	33.25	7.44	25.81
10.	30 55	22.91	—.05	—.02	1462	5.12	28.01	11.73	16.28
11.	13.27	9.95	.59	.22	762	2.67	12 84	16.02	—3.18
12.	10.55	7.91	.73	.27	447	1.57	9 75	20.31	—10.56
6b.	23.91	17.93	.30	.11	917	3.21	21.25	7 44	13.81
13.	31.84	23 88	.02	.01	1587	5 56	29.45	11 29	18.16
14.	36 53	27.41	—.70	—.26	1517	5 31	32.46	15 14	17.32
15.	25.34	19.00	1.80	.67	1232	4.31	23.98	18 99	4.99
6c.	29.77	22 33	.80	.30	1402	4.91	27.54	7 44	20.10

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



In this experiment, as in many others, it will be seen that the "nothing" plots have produced far less than in 1890, thus showing a good financial gain over the "nothing" plots, although the total yield from the plots was far less than last year.

Comparing the single element plots (1, 2 and 3) it becomes at once evident that phosphoric acid was the most deficient element, which conclusion is verified by comparing the following two plots, where similar amounts of phosphoric acid and potash are used in combination with equal rations of nitrate of soda. The average product of the mixed mineral plots is about equal to the sum of the products of plots 2 and 3 where phosphoric acid and potash were applied alone.

Looking at the nitrate of soda, (plots 7, 8 and 9) sulphate of ammonia, (plots 10, 11 and 12) and dried blood (plots 13, 14 and 15) groups, and comparing their yield with the average of the mixed mineral plots, (6, 6a, 6b and 6c) it will be seen that in only plots 9 and 13 were the applications of nitrogen accompanied with financial gain.

The result of particular interest in this experiment is the peculiar injurious effect noticed in the action of the sulphate of ammonia. It will be seen that in plot 10 where 1-3 ration of sulphate of ammonia was applied, the total value of the crop per acre over that of the "nothing" plots, was $28.01; in plot 11 where a 2-3 ration was applied, it was $12.84, and in plot 12 where a full ration was applied it was reduced to $9.75; while the value, above the average of the "nothing" plots, of the mixed mineral plot (No. 6) just before plot 10, is $33.25 and of the mixed mineral plot just following plot 12 is $21.25. We have here undoubted evidence that the application of sulphate of ammonia on this soil in connection with mixed minerals, has proved injurious to the Indian corn crop.

We infer from the results of the two years' experiments with

potash, (plot 3) that in 1890 there was, possibly, a small supply of available phosphoric acid in the soil and that, in connection with the potash applied, produced a fair yield. In 1891, the available phosphoric acid having been exhausted the previous year, the yield on plot 3 was light. Should this experiment be continued several years it is very probable that the phosphoric acid (plot 4) would maintain fair yields, owing to the natural supply of potash found in soils of granitic origin, to which this and most sandy soils of Rhode Island belong, while the potash plot (No. 3) would show a continual decrease.

It was suggested in the report of last year that some effort would be made to remedy the condition, should the sulphate of ammonia again exert a decidedly injurious effect upon the crop. In accordance with such a plan an attempt was made to determine if this condition *was* the result of delayed nitrification, due either to acidity of the soil or a possible absence of the nitric ferment. Accordingly the following course was adopted:

On July 27th 1-4th of each of the sulphate of ammonia plots was measured off and, to destroy any acidity that might be present in the soil, a very liberal amount of air slacked lime was applied and thoroughly mixed with the soil. Each of the plots thus treated was divided into halves, upon one of which was applied about one bushel of rich garden soil. This was done to introduce if possible the nitric ferment. The action of the nitric ferment is said to practically cease in time of severe drouth, and the dry weather, the last of July and the first of August, immediately following the application of the garden soil was sufficient to render the experiment valueless. The attempt will be repeated another year on a larger scale.

General Conclusions from the Kingston Experiment.

1. Phosphoric acid was most lacking, and next to it came pot-

ash, while nitrogen gave financial profits only when used in combination with both of the other elements.

2. In connection with the mixed minerals, nitrogen in the form of nitrate of soda gave far better results than in either of the other forms; and increased applications resulted in increased yields and profits.

3. Potash and phosphoric acid have changed places in order of deficiency; with that exception these conclusions are in exact accord with those of last year.

NEWPORT, R. I.

Hon. Melville Bull's Experiment.

This land was a part of the Hazard Farm, situated on Honeyman Hill, about two miles northeast of Newport. Accidentally, after the preliminary survey of the acre to be used for the experiment, the man working the adjoining land overreached his bounds, fertilized and planted part of the field, leaving then less than 4-5ths of an acre, which necessitated the omission of three of the mixed mineral plots (6a, 6b, and 6c) and one "nothing" plot, and very much crowded the only remaining unmanured plot. This, of course, lessened the value of the experiment.

The soil of this field was a loam with a clay subsoil,—what might be called "high wet land." For the past fifteen years it has been in grass and for the past ten years has not been manured. The grass was nearly run out and would not pay for mowing.

The soil had reached an extreme degree of exhaustion, and had the experiment been complete in every way, its continuance would have been accompanied with a great deal of interest.

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

No. of Plot.	Kind of Fertilizer.	Total Yield per Plot.			Total Yield per Acre.		
		Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
1.	Nitrate of Soda	70	12	77	20.00	3.57	1550
2.	Dissolved Bone-black.............	110	25	65	31.42	7 14	1300
3.	Muriate of Potash.	110	15	70	31.42	4.28	1400
4	Nitrate of Soda, Dissolved Bone-black, ...	150	17	82	42.85	5.00	1650
5.	Nitrate of Soda, Muriate of Potash, ...	135	15	70	38.57	4.28	1400
6.	Dissolved Bone-black, Muriate of Potash, } Mixed Minerals.	135	20	80	38.57	5.71	1600
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ¼ Ration, ...	120	17	82	34.28	5.00	1650
8.	Mixed Minerals as No. 6, Nitrate of Soda, ¾ Ration, ...	130	22	87	37.14	6.42	1750
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration, ..	107	35	92	30.71	10 00	1850
	Sulphate of Ammonia Group.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ¼ Ration, ..	105	30	105	30.00	8.57	2100
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ¾ Ration, ..	92	22	90	26 42	6.42	1800
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration.	112	27	95	32.14	7.85	1900
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ¼ Ration, ..	160	0	90	45.71	0.00	1800
14.	Mixed Minerals as No. 6, Dried Blood, ¾ Ration, ...	180	5	92	51.42	1.42	1850
15.	Mixed Minerals as No. 6, Dried Blood, full Ration, ...	165	7	110	47 14	2.14	2200
00.	Nothing	100	20	60	28.57	5 71	1200

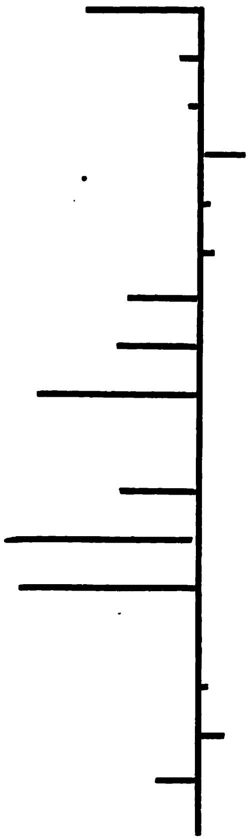
TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing plots it is shown by a minus (—) sign.

No of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Stover.	Stover.	Total value per acre of the corn and stover over that of the "nothing" plots.	Cost of Fertilizers per Acre.	Value of the Crop per Acre over the cost of the Fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 37½c. per bush.	lbs.	Value at $7 per ton.			
1.	—8.57	$6.43	—2.14	—$.80	350	$1.22	$6.01	$3.60	—$9.61
2.	2.85	2.14	1.43	.53	100	.35	3.02	4.38	—1.36
3.	2.85	2.14	—1.43	—.53	200	.70	2.31	3.06	—.75
4.	14 28	10.71	—.71	—.26	450	1.57	12.02	7.98	4.04
5.	10.00	7.50	—1.43	—.53	200	.70	7 67	6.66	1.01
6.	10.00	7.50	Same as average	Same as average.	400	1.40	8.90	7.44	1.46
7.	5.71	4.28	— 71	—.26	450	1 57	5.59	11.04	—5.45
8.	8.57	6.43	.71	.26	550	1.92	8.61	14.64	—6.03
9.	2.14	1.60	4.29	1 60	650	2.27	5.47	18.24	—12.77
10	1.43	1.07	2.86	1.07	900	3.15	5.29	11.73	—6.44
11.	—2.15	—1.61	.71	.26	600	2.10	.75	16.02	—15.27
12.	3 57	2.68	2.14	.80	700	2.45	5.93	20.31	—14.38
13.	16.14	12.11	—5.71	—2.14	600	2.10	12.07	11.29	.78
14.	22.85	17.14	—4.29	—1.61	650	2.27	17.80	15.14	2.66
15.	18.57	13.93	—3.57	—1.34	1000	3.50	16.09	18.99	—2.90

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.

No. of Plot.	Relative Losses.	Relative Gains.
1.	$9 61	
2.	1 36	
3.	75	
4.		$4 04
5.		1 01
6.		1 46
7.	5 45	
8.	6 03	
9.	12 77	
6a.	*	
10.	6 44	
11.	15 27	
12.	14 38	
6b.	*	
13.		78
14.		2 66
15.	2 90	
6c.	*	



* Omitted in this trial.

7

General Conclusions from the Newport Experiment.

1. This soil seemed to be decidedly lacking in nitrogen, phosphoric acid and potash. The greatest deficiency seemed to be with the phosphoric acid.

2. Of the forms of nitrogen, dried blood gave the best results; nitrate of soda doing a little better than sulphate of ammonia.

WESTERLY, R. I.

Mr. Courtland P. Chapman's Experiment.

This field of corn was very ripe when cut. The following is a description of the field in 1890, when the experiment was begun. "The soil was a good rich loam and slightly sandy. In 1884 the field was well fertilized with stable manure and sea-weed and planted with Indian corn. In 1885 it was fertilized with sea-weed, plowed and planted with potatoes, with 'phosphate' in the hill. In the spring of 1886 it was plowed and seeded with oats; from that time until 1890 it had been regularly mowed and but lightly top dressed."

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

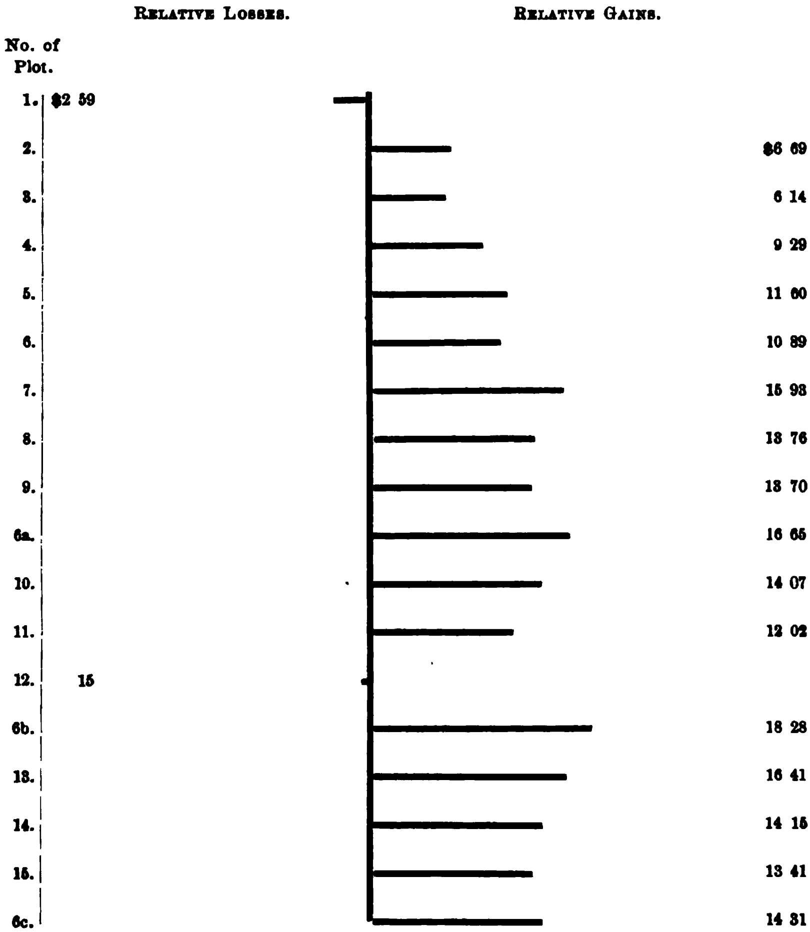
No. of Plot.	Kind of Fertilizer.	Total yield per Plot. Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Total yield per Acre. Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled)	Soft Corn, shelled, (70 lbs. on the cob. = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	15.0	17.5	42.5	4.28	5.00	850
1.	Nitrate of Soda	25.0	22.5	57.5	7.14	6.42	1150
2.	Dissolved Bone-black	55.0	45.0	75.0	15.71	12.85	1500
3.	Muriate of Potash	55.0	25.0	75.0	15.71	7.14	1500
4.	Nitrate of Soda, Dissolved Bone-black,	70.0	87.5	52.5	20.00	25.00	1050
5.	Nitrate of Soda, Muriate of Potash,	80.0	47.5	97.5	22.85	13.57	1950
6.	Dissolved Bone-black, Muriate of Potash, ... Mixed. Minerals.	77.5	40.0	117.5	22.14	11.42	2350
	Nitrate of Soda Group.						
7	Mixed Minerals as No. 6, Nitrate of Soda, ¼ Ration,	117.5	32.5	130.0	33.57	9.28	2600
8.	Mixed Minerals as No. 6, Nitrate of Soda, ¾ Ration,	122.5	32.5	135.0	35.00	9.28	2700
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	132.5	37.5	147.5	37.85	10.71	2950
6a.	Mixed Minerals as No. 6.	95.0	37.5	150.0	27.14	10.71	3000
	Sulphate of Ammonia Group.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ¼ Ration,	110.0	30.0	140.0	31.42	8.57	2800
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ¾ Ration,	125.0	22.5	137.5	35.71	6.42	2750
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration	85 0	32.5	132.5	24.28	9.28	2650
6b.	Mixed Minerals as No. 6	115.0	27.5	127 5	32.85	7.85	2550
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ¼ Ration,	125.0	27.5	125.0	35.71	7.85	2500
14.	Mixed Minerals as No. 6, Dried Blood, ¾ Ration,	120.0	42.5	140.0	34.28	12.14	2800
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	135.0	35.0	150.0	38.57	10.00	3000
6c.	Mixed Minerals as No. 6	95.0	50.0	97.5	27.14	14.28	1950
00.	Nothing	27.5	35.0	55.0	7.85	10.00	1100

TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Stover.	Stover.	Total value per acre of the corn and stover over that of the "nothing" plots.	Cost of Fertilizer per Acre.	Value of the Crop per Acre over the cost of the Fertilizer. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 87½c. per bush.	lbs.	Value at $7 per ton.			
1.	1.07	$0.80	—1 08	—$0.40	175	$0.61	$1.01	$3.60	—$2.59
2.	9.64	7.23	5.35	2.00	525	1.84	11.07	4.38	6.69
3.	9.64	7.23	—.36	.13	525	1.84	9.20	3.06	6.14
4.	13.93	10.45	17.50	6.56	75	0.26	17.27	7.98	9.29
5.	16.78	12.58	6.07	2.27	975	3.41	18.26	6.66	11 60
6.	16.07	12 05	3 92	1 47	1375	4 81	18.33	7.44	10.89
7.	27.50	20.62	1.78	.66	1625	5.69	26.97	11 04	15.93
8.	28.93	21.70	1.78	.66	1725	6.04	28.40	14.64	13.76
9.	31.78	23.83	3 21	1.20	1975	6.91	31.94	18.24	13.70
6a.	21.07	15.80	3.21	1.20	2025	7.09	24.09	7.44	16.65
10.	25.35	19.01	1.07	.40	1825	6.39	25.80	11.73	14.07
11.	29.64	22.23	—1.08	—.40	1775	6.21	28 04	16.02	12.02
12	18.21	13.66	1.78	.66	1675	5.86	20.18	20.31	—.15
6b.	26.78	20.08	.35	.13	1575	5.51	25.72	7.44	18.28
13.	29.64	22 23	.35	.13	1525	5.34	27.70	11.29	16.41
14.	28 21	21 16	4.64	1.74	1825	6.39	29.29	15.14	14.15
15.	32.50	24.37	2.50	.94	2025	7.09	32.40	18 99	13.41
6c.	21.07	15 80	6 78	2 54	975	3.41	21.75	7 44	14.31

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



Of the three single element plots (Nos. 1, 2 and 3), phosphoric acid produced the best results ; but comparing plots 4 and 5 where phosphoric acid and potash were applied in the same amounts as in the single element plots with the addition to each of equal amounts of nitrate of soda, the potash has given the best result.

Deducting the average of the gains of the mixed mineral plots (Nos. 6, 6a, 6b, and 6c) from the gains in the nine plots where mixed minerals were used in combination with the various forms and rations of nitrogen, we find that there was a financial loss arising from the use of nitrogen compounds in every case except plots 7 and 13, this loss being very light in plot 10, and 7, 10 and 13 being the three 1-3 ration plots, strengthens the conclusion that the application of a large amount of nitrogenous material to a soil comparatively rich in humus, is not accompanied with profit.

General Conclusions from the Westerly Experiment.

1. The soil of this field was about equally in need of phosphoric acid and potash, though the application of phosphoric acid gave a trifle better results.
2. Nitrogen in the form of dried blood gave better results than nitrate of soda. Sulphate of ammonia showing only slight gains.
3. The application of nitrogen was accompanied with financial gain only when applied in 1-3 rations and in combination with potash and phosphoric acid singly or together.
4. These results vary but little from those of last year.

SUMMIT, R. I.

Mr. Joseph A. Tillinghast's Experiment.

This field constituted a part of an old pasture which had not been plowed for 25 years. The exposure was a southwesterly one.

The soil upon plots 1, 2 and 3 was a light loam, and that of the following ones was gravelly, excepting plot 00, which was sandy loam.

Below we give three questions which accompanied Mr. Tillinghast's report, also the answers suggested by Dr. Wheeler.

Question 1. " Why does No. 4 show such a gain over last year and is its yield over No. 3 and No. 5 due to the phosphoric acid?"

Answer. " Because some of the phosphoric acid from last season probably remained in the soil. I think it is due to the phosphoric acid and the yield on No. 2 supports such a conclusion."

Question 2. " Why do plots Nos. 9 to 12 and 15 which receive the largest amounts of nitrogen yield less stover than those with 2-3 rations?"

Answer. " I can account for it only upon the supposition that plots 6a, 6b, and 6c acquired some of the nitrogen from the plots immediately above them. The hill being so steep, makes this very probable, since the *nitrates*—which are produced by the nitrification of the blood and sulphate—are known to leach very readily. (In case of phosphoric acid and potash there is less leaching.) The 2-3 ration nitrogen plots have in each case a nitrogen plot on either side of them and are consequently better protected from nitrogen robbery, than the full ration plots."

Question 3. " Why should plots Nos. 1, 3 and 5 yield so much less than last year?"

Answer. " Because last year's crop probably took most of the phosphoric acid which was available and without that no amount of nitrogen or potash will produce a crop. If the experiment were continued I should expect the results to be even more marked the coming season."

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

No. of Plot.	Kind of Fertilizer.	Total Yield per Plot. Hard Corn on the cob.	Total Yield per Plot. Soft Corn on the cob.	Total Yield per Plot. Stover.	Total Yield per Acre. Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Total Yield per Acre. Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Total Yield per Acre. Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	2.50	84.4	36.56	.71	2.41	731
1.	Nitrate of Soda	6.56	84.4	44.37	1.87	2.41	887
2.	Dissolved Bone-black	51.87	17.50	75.00	14.82	5.00	1500
3.	Muriate of Potash	7.81	11.56	49.12	2.23	3.30	982
4	Nitrate of Soda, Dissolved Bone-black,	150.62	14.06	101.25	43.03	4.02	2025
5.	Nitrate of Soda, Muriate of Potash,	17.81	13.44	45.62	5.09	3.84	912
6.	Dissolved Bone-black, Muriate of Potash, Mixed Minerals.	148.12	14.37	126.25	42.32	4.11	2525
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration,	131.87	9.37	157.50	37.68	2.68	3150
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration,	162.12	9.06	157.50	46.32	2.59	3150
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	159.37	9.69	117.50	45.53	2.77	2350
6a.	Mixed Minerals as No. 6	101.87	31.56	117.50	29.11	9.02	2350
	Sulphate of Ammonia Group.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration,	138.12	15.31	137.50	39.46	4.37	2750
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration,	216.87	10.62	212.50	61.96	3.03	4250
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration.	139.37	15.94	152.50	39.82	4.55	3050
6b.	Mixed Minerals as No. 6	114.37	19.37	140.00	32.68	5.53	2800
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration,	155.62	10.62	157.50	44.46	3.03	3150
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration,	191.87	10.31	177.50	54.82	2.95	3550
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	166.87	8.75	137.50	47 68	2.50	2750
6c.	Mixed Minerals as No. 6	103.12	16.87	132.50	29.46	4 82	2650
00.	Nothing	71 87	10.00	86.25	20 53	2.85	1725

TABLE SHOWING VALUES OF HARD CORN, SOFT CORN AND STOVER, ALSO TOTAL VALUE OF CROP PER ACRE AND VALUE, LESS THE COST OF FERTILIZERS.

	Value of Hard Corn at 75 c. per bushel.	Value of Soft Corn at 37½ c. per bush.	Value of Stover at $7 per ton.	Total value of the crop.	Cost of Fertilizers.	Value of crop above cost of Fertilizer.
0.	$0.53	$0 90	$2.56	$3.99	$0.00	$3.99
1.	1.41	.90	3.11	5.42	3.60	—1.82
2.	11.11	1.87	5.25	18.23	4.38	13.85
3.	1.67	1.24	3.44	6.35	3.06	3.29
4.	32.27	1.51	7.09	40.87	7.98	32.89
5.	3.82	1.44	3.19	8.45	6.66	1.79
6.	31.74	1.54	8.83	42.11	7.44	34.67
7.	28.26	1.00	11.02	40.28	11.04	29.24
8.	34.74	.97	11.02	46.73	14.64	32.09
9.	34.15	1.04	8.22	43.41	18.24	25.17
6a.	21.83	3.38	8.22	33.43	7.44	25.99
10.	29.59	1.64	9.62	40.85	11.73	29.12
11.	46.47	1.14	14.87	62.48	16.02	46.46
12.	29.86	1.71	10.67	42.24	20.31	21.93
6b.	24.51	2.07	9.80	36.38	7.44	28.94
13.	33.34	1.14	11.02	45.50	11.29	34.21
14.	41.11	1.11	12.42	54.64	15.14	39.50
15.	35.76	.94	9.62	46.42	18.99	27.43
6c.	22.09	1.81	9.27	33.17	7.44	25.73
00.	15.40	1.07	6.03	22.50	0.00	22.50

It would be unfair to arrange tables for this experiment on the same basis of comparison as in the other experiments, since the soil of the 00 plot had a great advantage over the rest of the field, due to the wash from the other plots.

By comparing the values of the crops from the various plots over the cost of the fertilizer it will at once be seen that potash and nitrate of soda, neither alone nor together, produced valuable yields. In no case are they profitable in comparison with the nearest nothing plots. But the application of phosphoric acid alone or in combination with nitrogen and potash produces gains which prove that phosphoric acid is decidedly the most deficient element.

We find by subtracting the average value of the crop above the cost of fertilizers where the mixed minerals were applied, from the value of the crop above tbe cost of fertilizers where nitrogen was used with mixed minerals, in plots 9, 12 and 15 (full ration plots), that the application of nitrogen resulted in financial loss; in plots 8, 11 and 14 (2-3 ration plots) the yield and net profit was the highest. The 1-3 ration plots (7, 10 and 13) gave only small profits.

Although the best yield was on the 2-3 ration sulphate of ammonia plot, (No. 11) the average yield of the dried blood plots was higher than that of the sulphate of ammonia plots; this, however, may be due to the increased natural fertility of the dried blood plots.

General Conclusions from the Summit Experiment.

1. "This soil was most deficient in phosphoric acid."

2. Potash seemed to be a trifle more deficient than nitrogen. Neither, alone or together, produced profitable yields, but either or both in combination with phosphoric acid gave large yields.

Sulphate of ammonia, 2-3 ration, produced the largest yield, but the average of the dried blood plots was a little better than the average of the sulphate of ammonia plots; while the yield of the nitrate of soda plots falls far behind. This may be due in part to differences in the soil.

ABBOTT RUN, R. I.

Mr. E. F. Crowninshield's Experiment.

The soil upon this field was a light sandy loam. In 1889 fertilizers were applied and a fair crop of Hungarian was grown. No barnyard manure was ever applied to the field. The ground has usually been plowed to the depth of about four or five inches. The following tables give the results of a second year's experiment.

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

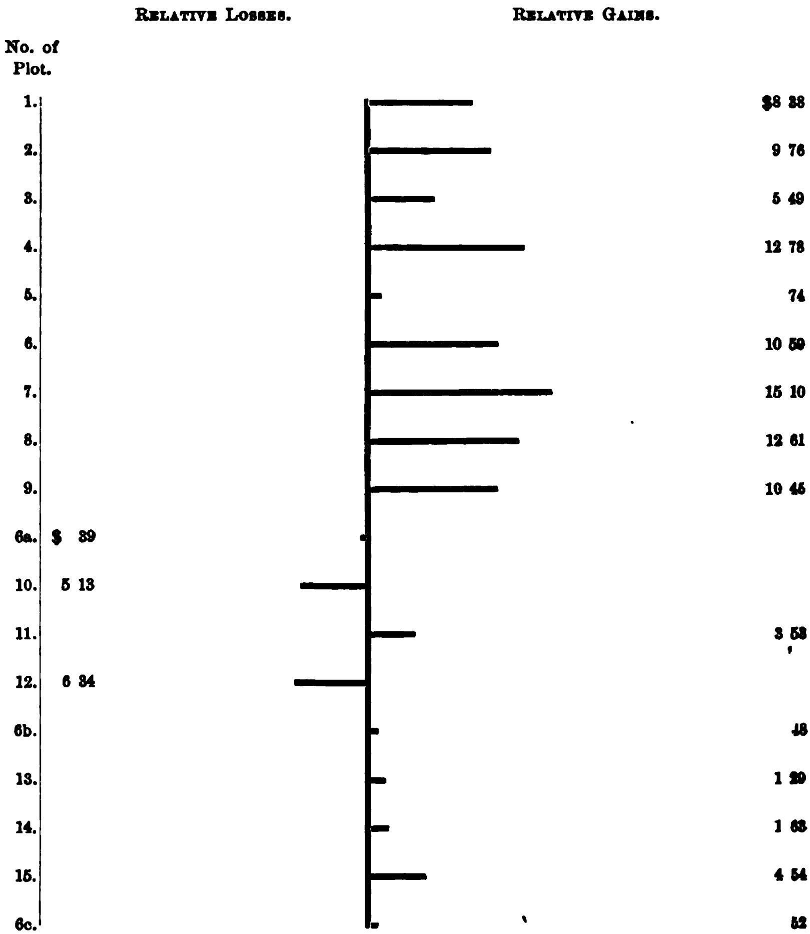
No. of Plot.	KIND OF FERTILIZER.	Total yield per Plot.			Total yield per Acre.		
		Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob =1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob =1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	9.5	6.5	34.0	2.71	1.85	680
1	Nitrate of Soda	72.0	5.0	65.0	20.57	1.43	1300
2.	Dissolved Bone-black	71.5	3.0	100.5	20 43	.85	2010
3.	Muriate of Potash	49.0	6.0	85.0	14.00	1.71	1700
4.	Nitrate of Soda, Dissolved Bone-black,	100.0	2.5	108 5	28.57	.71	2170
5.	Nitrate of Soda, Muriate of Potash,	43.0	8.0	84.0	12.28	2 28	1680
6.	Dissolved Bone-black, Muriate of Potash... Mixed Minerals.	88.0	6.0	101 0	25.14	1.71	2020
	NITRATE OF SODA GROUP.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ¼ Ration,	120 0	6.0	119.0	34.28	1.71	2380
8.	Mixed Minerals as No. 6, Nitrate of Soda, ¾ Ration,	118.0	6.0	141 0	33.71	1.71	2820
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration	126.0	4.0	140.0	36.00	1.14	2800
6a.	Mixed Minerals as No. 6	32.0	7.0	114 0	9.14	2 00	2280
	SULPHATE OF AMMONIA GROUP.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ¼ Ration,	35.0	8.0	97 0	10.00	2.28	1940
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ¾ Ration,	91.0	7.0	112.0	26.00	2.00	2240
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Rat'n,	54.0	10.0	141.0	15.43	2.85	2820
6b.	Mixed Minerals as No. 6.	32.0	8.0	125 0	9.14	2.28	2500
	DRIED BLOOD GROUP.						
13.	Mixed Minerals as No. 6, Dried Blood, ¼ Ration,	52.0	8.5	129.5	14 85	2 42	2590
14.	Mixed Minerals as No. 6, Dried Blood, ¾ Ration	71.0	10.0	129.0	20.28	2.85	2580
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	99 0	8.0	143.0	28.28	2.28	2860
6c.	Mixed Minerals as No. 6	27.0	10.0	123.0	7.71	2 85	2460
00	Nothing	27 0	10.0	73.0	7.71	2 85	1460

TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing plots it is shown by a minus (—) sign.

No of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Stover.	Stover.	Total value per acre of the corn and stover over that of the "nothing" plots.	Cost of Fertilizers per Acre.	Value of the Crop per Acre over the cost of the Fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 37½c. per bush.	lbs.	Value at $7 per ton.			
1.	15.36	$11.52	—.92	—$.34	230	$0.80	$11.98	$3.60	$8.38
2.	15.22	11.41	—1 50	—.56	940	3.29	14.14	4.38	9.76
3	8.79	6.59	—.64	—.24	630	2.20	8.55	3.06	5.49
4.	23.36	17.52	—1 64	—.61	1100	3.85	20.76	7.98	12.78
5	7.07	5 30	—.07	—.03	610	2.13	7 40	6.66	—.74
6	19.93	14 95	—.64	—.24	950	3.32	18.03	7.44	10.59
7.	29.07	21.80	—.64	—.24	1310	4 50	26.14	11.04	15.10
8.	28.50	21.37	—.64	— 24	1750	6.12	27.25	14.64	12.61
9.	30.79	23.09	—1.21	—.45	1730	6.05	28.69	18.24	10.45
6a.	3 93	2 95	—.35	—.13	1210	4.23	7.05	7.44	—.39
10	4.79	3 59	—.07	—.03	870	3.04	6.60	11.73	—5.13
11.	20 79	15.59	—.35	—.13	1170	4.09	19.55	16.02	3.53
12.	10.22	7.66	.50	.19	1750	6.12	13.97	20.31	—6.34
6b.	3.93	2 95	—.07	—.03	1430	5.00	7.92	7.44	.48
13.	9.64	7.23	.07	.03	1520	5.32	12.58	11.29	1.29
14	15.07	11.30	50	.19	1510	5.28	16 77	15.14	1.63
15.	23.07	17.30	— 07	—.03	1790	6.26	23.53	18.99	4.54
6c.	2 50	1.87	.50	.19	1390	4.86	6.92	7.44	.52

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



Comparing both the corn and stover yields from the single element plots, (1, 2 and 3) we at once see that phosphoric acid was the most deficient element, followed in order by nitrogen and potash. This same conclusion is obtained by a comparison of plots 4, 5, 6 and 7. Subtracting the gain of plot 5 from that of plot 7 we have, as a benefit from the addition of phosphoric acid, $14.32. Subtracting 6 from 7 we have $4.51 to be credited to the nitrogen added. Subtracting the gain of plot 4 from plot 7, we have $2.32 as gain in favor of potash.

In the special nitrogen test, (plots 7 to 15) we have conclusive proof of the superior value of nitrate of soda on this land.

Owing to the evident greater natural fertility of the soil in the region of the single element plots, it is unsafe to draw definite conclusions from their yields.

General Conclusions from the Abbott Run Experiment.

1. The soil was chiefly deficient in phosphoric acid, though nitrogen was greatly needed and the addition of potash gave only small gains.

2. Of the three forms of nitrogen, nitrate of soda produced the best results. Dried blood gave better yields than sulphate of ammonia.

3. The high yields of plots 1, 2 and 3 give further proof of the statement in last year's report, that the soil of that section was richer than the balance of the field.

4. These results and conclusions agree wholly with those of 1890.

HOPE VALLEY, R. I.

Mr. Herbert E. Lewis Experiment.

"This soil was a sandy loam, and the field had served for several years as a cow pasture." It was very noticeable that the corn on the nitrate of soda plots was much greener than any of the rest of the experiment, and that plot 5 was the least ripe of any. The same condition was noticed in the Westerly experiment.

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

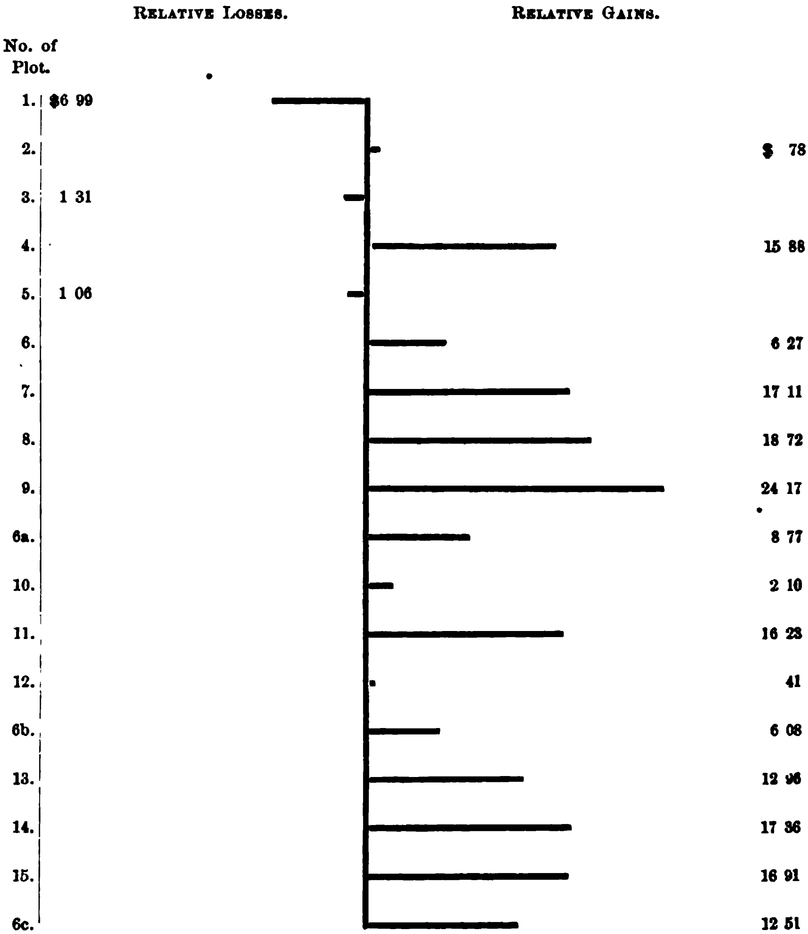
No. of Plot	Kind of Fertilizer.	Total yield per Plot. Hard Corn on the cob.	Total yield per Plot. Soft Corn on the cob.	Total yield per Plot. Stover.	Total yield per Acre. Hard Corn, shelled, (70 lbs. on the cob = 1 bushel shelled.)	Total yield per Acre. Soft Corn, shelled, (70 lbs. on the cob = 1 bushel shelled.)	Total yield per Acre. Stover.
		lbs.	lbs	lbs.	bush.	bush.	lbs.
0.	Nothing	41 00	4.0	55.0	11.71	1.14	1100
1	Nitrate of Soda	34.00	8.0	52.5	9.71	2.28	1050
2.	Dissolved Bone-black	65.00	4.5	85.0	18.57	1.28	1700
3.	Muriate of Potash	57.00	5.0	60.0	16.28	1.43	1200
4.	Nitrate of Soda, Dissolved Bone-black,	145.00	3.5	108.75	41.43	1.00	2175
5.	Nitrate of Soda, Muriate of Potash,	74.00	4.5	63.75	21.14	1.28	1275
6.	Dissolved Bone-black, Muriate of Potash, } Mixed Minerals.	100.5	3.5	100.00	28.71	1 00	2000
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ½ Ration,	161.00	4.25	120.00	46.00	1.21	2400
8.	Mixed Minerals as No. 6, Nitrate of Soda, ¾ Ration,	182.00	6.0	127.5	52.00	1.71	2550
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	212.00	10.0	158.75	60.57	2.85	3175
6a.	Mixed Minerals as No. 6	110.00	3.0	107.5	31.43	.85	2150
	Sulphate of Ammonia Group.						
10	Mixed Minerals as No. 6, Sulph. of Ammonia, ½ Ration,	102.00	1.5	100.00	29.14	.43	2000
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ¾ Ration,	178.00	2.0	130.00	50.85	.57	2600
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration.	132.00	2.75	105.00	37.71	.78	2100
6b.	Mixed Minerals as No. 6.	101 00	4.0	95.0	28.85	1.14	1900
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ½ Ration,	149.00	3.25	102.5	42.57	.93	2050
14.	Mixed Minerals as No. 6, Dried Blood, ¾ Ration,	169.25	5.5	155.0	48.35	1.57	3100
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	189.00	4.25	145.0	54.00	1.21	2900
6c.	Mixed Minerals as No. 6.	123.25	6.5	115.0	35.21	1.85	2300
00	Nothing	61.00	5.5	52.5	17.43	1.57	1050

TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Stover.	Stover.	Total value per acre of the corn and stover over that of the "nothing" plots.	Cost of Fertilizer per Acre.	Value of the Crop per Acre over the cost of the Fertilizer. A minus (—) sign indicates a loss.
	bush.	Value at 75 c. per bush.	bush.	Value at 37½ c. per bush.	lbs.	Value at $7 per ton.			
1.	—4.86	—$3.64	.92	$0.34	—25	—$0.09	—$3 39	$3 60	—$6.99
2.	4.00	3.00	—.08	—.03	625	2.19	5.16	4.38	.78
3.	1.71	1.28	.07	.03	125	.44	1.75	3.06	—1.31
4.	26.86	20.14	—.36	—.13	1100	3.85	23.86	7.98	15.85
5.	6.57	4.93	—.08	—.03	200	.70	5.60	6 66	—1 06
6.	14.14	10.60	—.36	—.13	925	3.24	13.71	7.44	6.27
7.	31.43	23.57	—.15	—.06	1325	4.64	28.15	11.04	17.11
8.	37.43	28.07	.35	.13	1475	5.16	33.36	14.64	18.72
9	46.00	34.50	1.50	.56	2100	7.35	42.41	18.24	24.17
6a.	16.86	12.64	—.51	—.19	1175	3.76	16.21	7.44	8.77
10.	14.57	10.93	—.93	—.34	925	3.24	13.83	11.73	2.10
11.	36.28	27.21	—.79	—.30	1525	5.34	32 25	16.02	16.23
12	23.14	17.35	—.58	—.22	1025	3.59	20.72	20.31	.40
6b.	14.28	10.71	—.22	—.08	825	2.89	13.52	7.44	6.08
13.	28.00	21.00	—.43	—.16	975	3.41	24.25	11.29	12.96
14.	33.78	25.33	.21	.08	2025	7.09	32.50	15.14	17.36
15.	39.43	29.57	—.15	—.06	1825	6.39	35.90	18.99	16 91
6c.	20.64	15.48	.49	.18	1225	4.29	19.95	7.44	12.51

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



Referring to the figures in the last column on page 65 we might conclude from the results of plots 1, 2 and 3 that the soil was chiefly in need of phosphoric acid, next potash and finally nitrogen; but the combinations with other elements (plots 4, 5 and 6) prove the lack of nitrogen to be greater than that of potash. This statement is again nicely proven in plot 7, which has the same fertilizer as plot 4, with the addition of potash, the same as plot 5, with the addition of phosphoric acid and the same as 6 with nitrogen added. Subtracting plot 4 from plot 7 we have left $1.23 as gain for potash. The difference between plots 5 and 7 is $18.17 the financial gain from adding phosphoric acid to nitrogen and potash. Taking 6 from 7 we have $10.84 to be credited to the nitrogen added.

In the special nitrogen test, nitrate of soda gave the best results, dried blood doing fairly well. While sulphate of ammonia gave the best results last year, it falls behind as in many other places this season.

It is possible, since dried blood is somewhat slow to act, that some of it remained in the soil from last year and helped this year's crop a little. This same condition is noticed in several other places.

General Conclusions from the Hope Valley Experiment.

1. This soil seems to be very deficient in phosphoric acid and considerably so in nitrogen.

2. In the special nitrogen tests, nitrogen in the form of nitrate of soda gave by far the best results and dried blood proved much better than sulphate of ammonia.

3. The application of fertilizers was accompanied with profit only where phosphoric acid was applied, and the profit was greatest where the full ration of nitrogen in the form of nitrate of soda was used in combination with phosphoric acid and potash.

4. Last year sulphate of ammonia produced the best results, this year nitrate of soda is ahead. Otherwise the results of the two years agree.

JAMESTOWN, R. I.

Mr. T. A. H. Tefft's Experiment.

This soil was a light sand with a gravelly subsoil.

The last application of manure was about twelve years ago, since which time it has grown two crops of corn and one each of oats and rye.

During the last seven years it has been in grass, but "when it was plowed last spring it was not swarded over, there being only now and then a tuft of grass."

The ears of hard corn on the nothing plots had only four rows of kernels, while the soft corn was nearly all cob. The corn on the dried blood plots seemed to roll more in the drouth than any of the rest. The following are the results, in tables:

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

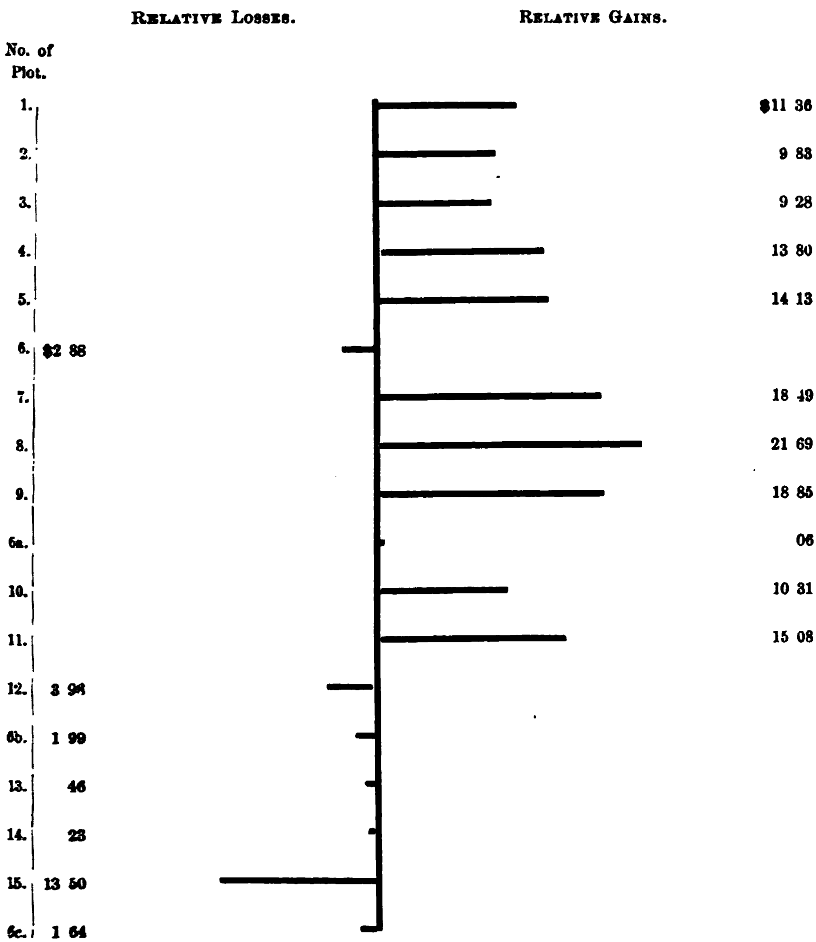
No. of Plot.	Kind of Fertilizer.	Total Yield per Plot. Hard Corn on the cob.	Total Yield per Plot. Soft Corn on the cob.	Total Yield per Plot. Stover.	Total Yield per Acre. Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Total Yield per Acre. Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Total Yield per Acre. Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	37.5	35.00	100.0	10.71	10.00	2000
1.	Nitrate of Soda	85.0	33.75	135.0	24.28	9.64	2700
2.	Dissolved Bone-black	82.5	35.00	130.0	23.57	10.00	2600
3.	Muriate of Potash	73.75	40.00	122.5	21.07	11.43	2450
4	Nitrate of Soda, Dissolved Bone-black,	120.00	22.50	142.5	24.28	6.43	2850
5.	Nitrate of Soda, Muriate of Potash,	115.00	25.00	140.0	32.85	7.14	2800
6.	Dissolved Bone-black, Muriate of Potash, } Mixed Minerals.	42.50	25.00	130.0	12.14	7.14	2600
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration,	145.00	40.00	150.0	41.42	11.43	3000
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration,	175.00	23.75	180.0	50.00	6.78	3600
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	180.00	27.50	170.0	51.42	7.85	3400
6a.	Mixed Minerals as No. 6	50.00	32.50	137.5	14.28	9.28	2750
	Sulphate of Ammonia Group.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration,	120.00	25.00	142.5	34.28	7.14	2850
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration,	152.50	20.00	180.0	43.57	5.71	3600
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration.	92.50	25.00	145.0	26.43	7.14	2900
6b.	Mixed Minerals as No. 6	37.50	40.00	135.0	10.71	11.43	2700
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration,	77.50	20.00	120.0	22.14	5.71	2400
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration,	85.00	30.00	140.0	24.28	8.57	2800
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	55.00	25.00	105.0	15 71	7.14	2100
6c.	Mixed Minerals as No. 6	42.50	30.00	140.0	12.14	8 57	2800
00.	Nothing	21 25	20.00	102.5	6 07	5.71	2050

TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and valuè is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Stover.	Stover.	Total value per acre of the corn and stover over that of the "nothing" plots.	Cost of Fertilizer per Acre.	Value of the Crop per Acre over the cost of the Fertilizer. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 37½c. per bush.	lbs.	Value at $7 per ton.			
1.	15.89	$11 92	1 79	$0.67	675	$2 37	$14 96	$3 60	$11 36
2.	15.18	11.38	2.15	.81	575	2.02	14.21	4.38	9.83
3.	12.68	9.51	3.58	1.34	425	1.49	12.34	3.06	9.28
4.	25.89	19.42	—1.42	—.53	825	2.89	21.78	7.98	13 80
5.	24.46	18.34	—.71	—.27	775	2.72	20 79	6.66	14 13
6.	3.75	2 81	— 71	— 27	575	2 02	4.56	7.44	—2.88
7.	33.03	24.77	3 58	1.34	975	3 42	29.53	11 04	18.49
8.	41.61	31.21	—1.07	—.40	1575	5.52	36.33	14.64	21.69
9.	43.03	32.27	Same as average	Same as average	1375	4 82	37.09	18.24	18 85
6a.	5.89	4 42	1.43	.54	725	2.54	7.50	7.44	.06
10.	25.89	19.42	—.71	—.27	825	2.89	22.04	11.73	10.31
11.	35.18	26.38	—2.14	— 80	1575	5.52	31 10	16.02	15.08
12	18.04	13.53	—.71	— 27	875	3.07	16 33	20.31	—3.98
6b.	2.32	1.74	3.58	1.34	675	2.37	5.45	7 44	—1.99
13	13.75	10.31	—2.14	—.80	375	1.32	10.83	11 29	—.46
14.	15.89	11 92	.72	.27	775	2 72	14.91	15 14	—.23
15.	7.32	5.49	—.71	—.27	75	.27	5.49	18 99	—13.50
6c.	3.75	2 81	.72	.27	775	2.72	5.80	7 44	—1.64

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



It is very evident from these results that this soil has not, in the past, been supplied with the necessary amount of nitrogen. Comparing plots 1, 2 and 3 we notice that the single elements produced results as follows: nitrogen, the highest, next, phosphoric acid, and lastly, potash. Comparing plots 4, 5 and 6 we notice that where nitrogen was applied (plots 4 and 5) the yield was far greater than in No. 6 where only phosphoric acid and potash were applied together. This light yield from the application of phosphoric acid and potash is apparent in all the mixed mineral (6, 6a, 6b and 6c) plots.

The addition of nitrogen in the form of nitrate of soda shows a marked advantage over sulphate of ammonia and dried blood.

It will be of great interest to watch this experimental field for another year, before which time no definite conclusions, further than its great need of nitrogen, can be drawn.

General Conclusions from the Jamestown Experiment.

1. Although all three elements were lacking, this soil was especially in need of nitrogen. Phosphoric acid and potash were about equal in deficiency.

2. Nitrogen in the form of nitrate of soda produced by far the best results, while sulphate of ammonia, in moderate quantities gave profitable returns; the application of dried blood in every case was accompanied with financial loss.

NOOSENECK, R. I.

Mr. J. B. Vaughan's Experiment.

This corn had a very poor start and was greatly injured by the crows. The following is the description of the soil when the experiment was begun in 1890.

"The soil was a poor and sandy loam and the field had not been planted or fertilized since 1884; the crop grown at that time being fodder-corn manured in the drill.

"In many places there was little or no sod, and at the time the field was surveyed and plotted there was almost nothing growing upon it save bluets (Houstonia cærulea) and bird-foot violets (Viola pedata).

"Several isolated clusters of the common blue lupine (Lupinus perennis) were to be seen growing profusely. This plant is generally found on neglected, sandy fields and by sandy road-sides, and belongs to the family of plants known as the 'Leguminosæ,' the lupine and several other members of which have been shown by Atwater, Hellriegel and others to be able to draw their supply of nitrogen largely from the air.

"As will be seen from the tables which follow, this soil appeared to be decidedly deficient in nitrogen, but, nevertheless, the lupine, one of the class of plants richest of all in nitrogen, was able to attain perfect development. This was a good object lesson, showing that Nature provides for herself, for this plant was at work probably gathering nitrogen from the air and thus furnishing to the soil by its decay the most costly of the lacking elements. To the same end other of the lupines, the horse-bean and cow-pea have been introduced for use in green manuring."

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

No. of Plot.	KIND OF FERTILIZER.	Total yield per Plot.			Total yield per Acre.		
		Hard Corn on the cob.	Soft Corn on the cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob =1 bush. shelled)	Soft Corn, shelled, (70 lbs. on the cob =1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing..................................	61.25	3.75	60.00	17.50	1.07	1200
1	Nitrate of Soda..........................	78.75	3.75	55.00	22.50	1.07	1100
2.	Dissolved Bone-black................	71.25	3.75	65.62	20 35	1 07	1312
3.	Muriate of Potash.....................	68.75	2.50	56.25	19.64	.71	1125
4.	{ Nitrate of Soda, Dissolved Bone-black, }	91.25	1.25	60 00	26.07	.36	1200
5.	{ Nitrate of Soda, Muriate of Potash, }	107.50	2.50	60.00	30.71	.71	1200
6.	{ Dissolved Bone-black Muriate of Potash... } Mixed Minerals.	103 75	5.00	102 50	29.64	1.43	2050
	NITRATE OF SODA GROUP.						
7.	{ Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration, }	113 75	5.00	92.50	32.50	1.43	1850
8.	{ Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration, } ...	145.00	2.50	90 00	41.43	.71	1800
9.	{ Mixed Minerals as No. 6, Nitrate of Soda, full Ration } ...	136.25	5.00	83.75	38 93	1.43	1675
6a.	Mixed Minerals as No. 6..........	133.75	7.50	107 50	38.21	2 14	2150
	SULPHATE OF AMMONIA GROUP.						
10.	{ Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration, }	91.25	1.25	82 50	26.07	.36	1650
11.	{ Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration, }	141.25	1.25	88 75	40.35	.36	1775
12.	{ Mixed Minerals as No. 6, Sulph. of Ammonia, full Rat'n, }	146.25	5.00	115.00	41.78	1.43	2300
6b.	Mixed Minerals as No. 6.	86.25	10.00	97 50	24.64	2.85	1950
	DRIED BLOOD GROUP.						
13.	{ Mixed Minerals as No. 6, Dried Blood, ⅓ Ration, } ...	133.75	2.50	92 50	38 21	.71	1850
14	{ Mixed Minerals as No. 6, Dried Blood, ⅔ Ration } ...	118.75	2.50	91.25	33.93	.71	1825
15.	{ Mixed Minerals as No. 6, Dried Blood, full Ration, }	143.75	3.75	100.00	41.07	1.07	2000
6c.	Mixed Minerals as No. 6..........	125.00	1.25	97.50	35.71	36	1950
00	Nothing.................................	75.00	3.75	43.75	21.43	1.07	875

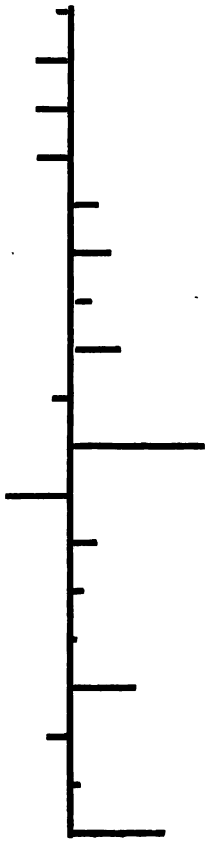
TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE, OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Stover.	Stover.	Total value per acre of the corn and stover over that of the "nothing" plots.	Cost of Fertilizers per Acre.	Value of the Crop per Acre over the cost of the Fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 37½c. per bush.	lbs.	Value at $7 per ton.			
1.	3.04	$2.28	same as	average.	62	$0.22	$2.50	$3.60	—$1.10
2.	.89	.66	same as	average.	275	.96	1.62	4.38	—2.76
3.	.18	.13	—.36	—$.13	87	.31	.31	3.06	—2.75
4.	6.61	4.96	— 71	—.27	162	.57	5.26	7.98	—2.72
5	11.25	8.44	—.36	—.13	162	.57	8.88	6.66	2.22
6	10.18	7.63	.36	.13	1012	3.54	11.30	7.44	3.86
7.	13.04	9.78	.36	.13	812	2 84	12.75	11.04	1.71
8.	21.97	16.48	—.36	—.13	762	2.67	19.02	14.64	4.38
9.	19.47	14.60	.36	.13	637	2.23	16.96	18.24	—1.28
6a.	18.75	14.06	1.07	.40	1112	3.89	18.35	7.44	10.91
10	6.61	4.96	—.71	—.27	612	2.14	6.83	11.73	—4.90
11.	20 89	15.66	—.71	—.27	737	2.58	17.97	16.02	1.95
12.	22.32	16.74	.36	.13	1262	4.42	21.29	20.31	.98
6b.	5.18	3.88	1.78	.67	912	3.19	7.74	7.44	.30
13.	18.75	14.06	—.36	—.13	812	2.84	16.77	11.29	5.48
14.	14.47	10.85	— 36	—.13	797	2.76	13.48	15.14	—1.66
15.	21.61	16.21	same as	average.	962	3.37	19.58	18.99	.59
6c.	16.25	12.19	—.71	—.27	912	3.19	15.11	7.44	7.66

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.

No. of Plot.	Relative Losses.	Relative Gains.
1.	$1 10	
2.	2 76	
3.	2 75	
4.	2 72	
5.		$2 22
6.		3 86
7.		1 71
8.		4 38
9.	1 28	
6a.		10 91
10.	4 90	
11.		1 95
12.		98
6b.		30
13.		5 48
14.	1 66	
15.		59
6c.		7 67



Although the application of phosphoric acid and potash in the single element plots, (Nos. 2 and 3) did not give as large yields as did the nitrate of soda in plot 1, the application of the two combined, as in plots 6, 6a, 6b and 6c, proved these two elements more profitable in combination than where nitrogen in addition was applied.

There is but little difference in the product of the nitrogen plots (7 to 15) *i. e.*, where nitrate of soda, sulphate of ammonia and dried blood are applied with the mixed minerals. Dried blood yielded the largest crop and sulphate of ammonia the smallest. The addition of nitrogen to mixed minerals ,has in every case except one (plot 10) increased the total yield but it will be seen by subtracting the average financial gains ($5.68) of the mixed mineral plots (6, 6a, 6b and 6c) that the addition of nitrogen to the mixed minerals in no case produced sufficient yields to compensate for the extra cost.

General Conclusions from the Nooseneck Experiment.

1. This soil was greatly lacking in phosphoric acid and nitrogen. It was apparently most in need of nitrogen, while in phosphoric acid and potash it showed a more equal deficiency. Owing to the high price of nitrogen, its addition to mixed minerals did not produce yield commensurate with its cost.

2. Dried blood proved to be the most profitable form of nitrogen applied, and nitrate of soda gave better returns than sulphate of ammonia.

3. Since the field was especially lacking in phosphoric acid the good showing for the blood may, probably, to some extent, be due to the amount of phosphoric acid which it contained.

DAVISVILLE, R. I.

Mr. A. A. Sherman's Experiment.

The soil on which this experiment was conducted is of a good degree of fertility, a characteristic of all the land under Mr. Sherman's management, thus producing a very large crop of corn. This very fertile condition of the soil renders the benefits from small applications of fertilizers proportionately light and thus presents difficulties in comparisons and in drawing any definite conclusions, more than that the application of highly nitrogenous manures to soils containing a great amount of humus and in a high state of fertility is not accompanied with adequate profit.

The above fact, in addition to unfortunate breaking into the field by farm animals have rendered it impossible to draw further definite conclusions from the results of Mr. Sherman's experiment.

For these reasons, in this instance, we omit the tables.

LIME ROCK, R. I.

Mr. H. Hartwell Jencks' Experiment.

As stated in the last report, the soil of this field was very variable in character and condition and another season's trial has been no more satisfactory than that of last year. As no definite conclusions can be reached by a comparison of the figures the tables are omitted.

GENERAL RESULTS OF THE EXPERIMENTS.

The plots manifest nearly all the same conditions the second year that were noticed the first year of the experiment.

While in four cases in 1890 potash appeared the most deficient, it has in no case upon a second trial been found so much lacking as phosphoric acid. It may be stated in general that our Rhode Island soils are probably more deficient in available phosphoric acid than in potash, which is accounted for by the fact of their granitic origin, and consequent natural supply of potash.

With very few exceptions the ⅔ rations of nitrogen have given the best results; as a rule the application of small quantities has given very small profits, and the application of large amounts has often resulted in financial loss.

Of the three forms of nitrogen, nitrate of soda has, upon the whole, proved the most profitable, and sulphate of ammonia the least.

In most of the plots where dried blood was applied, the corn ripened earlier and showed, when compared with the nitrate of soda and sulphate of ammonia plots, a greater relative yield than in 1890. This gain may be due to the fact that the dried blood contained, in addition to the organic nitrogen, a small amount of phosphoric acid, and this amount was unusually great in the blood used in 1891. The phosphoric acid may have increased the yield. Another cause for the increased yield might be,—since nitrification of dried blood is somewhat slow,—that in all probability some of the nitrogen applied on these plots in 1890 was unused until 1891.

The most profitable fertilizer used in these experiments was composed of a mixture per acre of about 350 pounds of dissolved bone-black, 130 to 150 pounds muriate of pot-

ash, with 300 pounds nitrate of soda or 230 pounds sulphate of ammonia or 440 pounds dried blood; a fertilizer containing about 45 pounds of nitrogen, 75 pounds of potash and 54 pounds of phosphoric acid per acre.

In the Hope Valley, Summit, Abbott Run and Kingston experiments the above compounds might be modified by increasing the phosphoric acid and decreasing the potash; in the Jamestown and Nooseneck experiments a little more nitrogen might replace a part of the potash and phosphoric acid with advantage.

Special qualities of each of the three forms of nitrogen render the exercise of caution necessary in their use. Nitrate of soda, the most available form of nitrogen, is very easily leached or washed out of the soil. Sulphate of ammonia, though not so easily leached, must probably undergo the nitrification process before the plant can use it, and as this process requires a warm, moist alkaline soil and the presence of the nitric ferment, there is danger of the ammonia remaining unnitrified until too late to be utilized by the crop, and as this material is all liable to leach away before another crop can be grown on the same soil, it is not safe to be wholly depended upon. Dried blood is equally slow to nitrify, but it is not liable to wash out.

It seems advisable in preparing a fertilizer to use the above forms of potash and phosphoric acid, and apply a part of each of the forms of nitrogen, — say ½ of nitrate of soda to give the corn an early start, and the other half of sulphate of ammonia or dried blood, or both, to help the corn along during the latter period of its growth.

The average relative weights of corn and stover from eighteen fields of this variety of corn (White Capped) has been determined and found to be 57 lbs. of stover to each bushel (70 lbs.), — that is to say, 100 lbs. corn in the shock

contains 55 lbs. of corn and 45 lbs. of stover. It has also been determined by the Massachusetts State Agricultural Experiment Station (Eighth Annual Report, 1890, pages 297 and 299). as a result of twenty-nine analyses, that corn and cobs contain 1.409 per cent. nitrogen, .571 per cent. phosphoric acid, and .472 per cent. potassium oxide, and that corn-stover, average of sixteen analyses, contains 1.043 per cent. nitrogen, .293 per cent. phosphoric acid, and 1.400 per cent. potassium oxide. Accordingly a crop of 50 bushels of corn to the acre would contain 79.0405 lbs. of nitrogen, 28.3355 lbs. of phosphoric acid, and 56.42 lbs. of potassium oxide.

More might have been said in regard to the results of these experiments but I have been very careful to make no statement nor conclusion that was not perfectly plain and substantiated by the results of a careful experiment. In the exercise of caution in this work, I have sought the advice of Prof. Chas. O. Flagg and Dr. H. J. Wheeler. To them and to the gentlemen who have been so indulgent of their time and trouble and willingly co-operated in the success of these experiments, I wish to acknowledge my sincere thanks.

CHEMICAL DIVISION.

H. J. WHEELER.

During the past year there has been a considerable increase in the number of materials sent in from about the State for chemical examination. Work on such material occupied the early portion of the year. Late in the winter an arrangement was made by which the analyses of fertilizers for the State Board of Agriculture should be made in the laboratory of this Station, and by which the results of the same should be published in Station Bulletins. During the spring the various sections of the State were visited by me or my assistant, in part in company with the Secretary of the State Board of Agriculture, for the purpose of collecting samples of such brands of fertilizers as were to be found on the market. Seventy-one such samples were collected and analyzed. Determinations were made of nitrogen in the form of ammoniates, nitrates and organic matter, and of phosphoric acid, in its several forms. These and other miscellaneous analyses have been published in Bulletins 11, 12 and 13 which have been issued by this division during the year.

The analyses of commercial fertilizers were also compiled and embodied in my report on the same which has been transmitted to the Secretary of the State Board of Agriculture for publication in their annual report.

During the year a water-blast, a large distilling apparatus for making distilled water and other minor additions have been made to the laboratory outfit.

Until the present time one wing of the laboratory building has furnished sufficient accommodations, but should the work of the division increase according to present indications, the other wing,

now used by the school for a chemical laboratory, will be required by the Station.

In order to properly attend to the analytical work in connection with the state fertilizer inspection, I found it necessary to employ an assistant. Mr. B. L. Hartwell, for two years assistant chemist at the Massachusetts State Agricultural Experiment Station, was secured to fill this position. He entered upon his duties on June 1st, and to his efficient services is due a full share of credit for the work of this division.

I append here such analyses for the year as have not already been published in Station Bulletins, Nos. 11, 12 and 13. The miscellaneous analyses are numbered independently of those fertilizers belonging to the State inspection, which form by themselves a distinct series.

ANALYSES OF WATER SENT FOR EXAMINATION.

(PARTS PER MILLION.)

Number.		Actual ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100 c.	Solids at red heat.	Lead.	Party Sending and Locality.
5	Well Water	0.00	0.10	10.00	......	......	......	Station Farm, Kingston.
18	Spring Water	0.02	0.09	10.00	38.00	22 00	......	Chas. G. Champlin, Narragansett.
22	Well Water	....	....	82.00	......	......	......	H. H. Huntington, Saylesville.
51	Well Water	0.21	0.20	36.00	......	......	None.	Robert Kinnicutt, Warren.
34	Well Water	0.02	0.08	16.00	......	......	......	Mrs. J. E. Wells, Kingston.
84	Two weeks later	....	....	15.00	......	......	......	Mrs. J. E. Wells, Kingston.
35	"Boiling Spring," Sept. 23, 1891	....	....	8.00	......	......	......	Collected as sample of probably uncontaminated water, Kingston.
50	Well Water	....	....	24.00	......	......	......	Rev. J. H. Wells, Kingston.
32	Artesian Well Water, Sept. 23, 1891	....	....	13.00	......	......	......	Station and School supply, Kingston.
32	Artesian Well Water, Feb. 1, 1892	....	....	11.00	......	......	......	Station and School supply, Kingston.
36	Well Water	0.10	0.23	9.50	......	......	......	Isaac Blanchard, Wakefield.

Whether the impurities in No. 51 came from the water or the vessels in which it was sent, it was impossible to determine. Parties sending water for analyses should send in glass stoppered bottles or use *new* corks. The bottles whether old or new must be most carefully cleaned, without soap, and rinsed before filling, with some of the water to be sampled. When possible we prefer to furnish a bottle for the purpose.

A few remarks on the contamination of wells, etc., may be found in Bulletin 11, page 144.

No. 29. Contents of a hen's crop and stomach sent from Peace Dale. R. I. Both arsenic and copper (the constituents of Paris Green) were found in considerable quantities.

No. 33. Sample of grapes from the Horticultural Division which had been sprayed with "Bordeaux Mixture." The grapes had been washed in vinegar. Only slight traces of copper were found on the sample tested.

No. 39. Sample of honey from the Apicultural Division to be tested for copper. Not enough copper was present to give a decided reaction.

Nos. 37 and 38. Commercial Fertilizers "I" and "II" from C. C. Reynolds, Exeter, R. I. In each of these samples the total phosphoric acid, nitrogen and potash was determined. The goods had been bought for the same brand throughout but upon receipt of the same it was found that the packages did not all bear the same guaranty. The chemical analyses showed the material to be practically of a uniform composition. The analyses, having no general interest, are not reported.

Nos. 40 and 41. Samples of sugar beets grown on the Station farm during the summer of 1891.

40. "Balteau Desprez Richest."

41. "Florimond Desprez Richest."

	40.	41.
Cane sugar,	13.39 per cent.	13.56 per cent.

The other varieties were not sufficiently developed for analysis. The sugar was determined by the alcohol digestion method * (Rapp-Degener).

Nos. 42 to 49 inclusive and 52 are analyses of poultry foods which were made for the poultry division.

No. 30.

Bran, sent by C. H. Knowles, Point Judith, R. I.	No. of pounds in 100 lbs. of original substance.	No. of pounds in 100 lbs. of dry substance.	Per cent. of digestibility of constituents, for ruminants.	No. of pounds digestible in 100 lbs. of original substance.	Nutritive ratio.
Crude Ash	6.53	7.14	....	....	
Crude Proteine, (nitrogenous matter.)	15.50	16.94	78	12 09	
Crude Fat (Ether extract)	4.42	4.83	70	3.09	
Non-nitrogenous extract matter	56.32	61.54	77	43.37	1:4.46
Crude Fibre (Cellulose.)	8.74	9.55	33	2.88	
Total Dry matter	91.51	......		....	
Moisture at 100°C	8.49	......		.....	
	100.00	100.00		61 43	

* Frühling und Schulz, Zucker Industrie, page 146.

NO. 31.

*Gluten meal, sent by David O. Cargill, Abbott Run, R. I.	No. of pounds in 100 lbs. of original substance.	No. of pounds in 100 lbs. of dry substance.	Per cent. of digestibility of constituents, for ruminants.†	No. of pounds digestible in 100 lbs. of original substance.	Nutritive ratio.
Crude Ash........................	1.25	1.32	.....	....	
Crude Proteine, (nitrogenous matter.)	24.06	25.54	79	19.01	
Crude Fat (Ether extract.)........	9.40	9 98	85	7.99	
Non-nitrogenous extract matter......	55.03	58.43	91	50.08	1:3.83
Crude Fibre (Cellulose.).............	4.46	4.73	62	2.77	
Total Dry Matter................	94.20	...		.....	
Moisture at 100°C............	5 80	...		.....	
	100.00	100.00		79.85	

† Estimated the same as for Indian corn.

* Manufactured by the American Glucose Co., Buffalo, N. Y.

HORTICULTURAL DIVISION.

L. F. KINNEY.

During the past two years the trees in the trial orchards have made a strong and healthy growth and with the exception of the apples and pears, most of them have formed fruit buds and will soon be in a bearing condition. New varieties have been added from time to time by purchase and donation, and choice kinds of apple and pear scions that have been sent to the Station for trial, have been grafted into old established trees to hasten their season of fruiting.

The vineyard has been enlarged by planting, beside the trial vines, four hundred Worden, Moore's Early, Concord and Delaware vines for experimental purposes, and in a like manner the plantations of raspberries, blackberries and strawberries have been expanded. Apple, pear and peach seedlings have been grown, grafted and budded; and forest and ornamental tree seedlings and vines have been started. A plantation of one thousand White Ash (*Fraxinus Americana. L.*) and Black Walnut (*Juglans nigra. L.*) trees has also been made for forest purposes.

A limited amount of attention has been given to the cultivation of ornamental shrubbery, of which a good collection is now growing upon the Station grounds—and the choicer kinds of herbaceous flowering plants, such as Japanese and Chinese chrysanthemums, French flowering Cannas, tuberous rooted begonias, etc., have been grown in small varieties.

A number of new varieties of vegetables have been grown without marked results. A comparative test was made with onion plants that were started under glass and those that were grown in the open field with conclusions favoring the former method, reported in Bulletin No. 14.

The arsenites have been used to destroy the larvæ of the Codling moth, Tent caterpillar and the Rose beetle, and also the leading fungicides in the treatment of various fungous diseases. A bulletin giving general information concerning the preparation and use of insecticides and fungicides with descriptions of apparatus employed in applying them will be issued in the spring.

Investigations have been made concerning the conditions which favor the development of the potato scab, in the field and these experiments have been continued under glass. The Bordeaux mixture has been successfully used in preventing the potato "Scab" and the potato "Blight" and "Rot." The results of these latter experiments, so far as completed, were published in Bulletin No. 14, of this Station.

POULTRY DIVISION.

SAMUEL CUSHMAN.

At a meeting of the Board of Managers held February 12, 1891, we were engaged to commence, April 1st, (in addition to the management of the Apicultural Division) experiments relating to the poultry interests of the State.

With this position was given the privilege of visiting various parties in New Jersey, Long Island and New England, to study the latest improvements in raising poultry by artificial methods.

Nearly all the books on poultry raising that were in the market, as well as back numbers of two of the most practical poultry magazines, were immediately procured for a working library.

As much had been written in poultry and farm papers about capons and the profit of raising them and as very few were produced in this State, an experiment with capons was commenced. The subject was read up, an advertised set of instruments bought and the operation successfully performed on several birds. Soon after, while looking up poultry matters in the New York City markets, we learned where most of the New Jersey capons were produced and during our trip among the broiler establishments of that State those sections were visited. Here the fastest and most successful caponizers were seen at their work, their manner of operating learned and their tools procured, and we have since followed their methods. A Bulletin on "Capons and Caponizing," giving the results of our experiments with capons and full directions for performing the operation will be issued later.

The land set apart for the use of the Poultry Division contains about seven acres. It is below the hill and protected by it from the north and east winds. On the west and south where the wind has full sweep, a double row of trees, Austrian Pines and Larches, were planted for a future wind break. The ground slopes to the west and south and is enough above the plain to be safe from spring floods. The soil is a gravelly loam and naturally dry. A brook runs through the southern and lower portion of the ground and except during the dry part of the season furnishes an abundance of water for ducks and geese. A natural spring in the northeast corner gives a continuous supply of excellent water for drinking, and other purposes.

A work shop or feed room was fitted up in the quarry blacksmith shop, which was on the poultry department grounds. This room was floored and sealed and provided with windows, work-bench, grain bins, stove for cooking feed, sink, &c. Adjoining this, a narrow room for setting hens was made and, on one side, tiers of nests were arranged on shelves. A poultry house 8 x 8 with open shed the same dimensions attached, and several small movable shed-houses 3 x 3 1-2 for hens and chickens, were built. A small flock of Light Brahma fowls was procured and from them a nice lot of chicks were reared.

The hatching and rearing of chickens in winter by artificial heat has received much attention in various parts of this country and especially in New Jersey. In that State scores of people are engaged in the extensive production of chicken broilers for the Philadelphia and New York markets and establishments having a capacity of several thousand chicks are quite numerous. In Hammonton so many have taken up this industry that the town has become famous as a broiler raising centre. Probably more incubators and brooders have been operated at one time in this place than in any other part of the United States. In the past so many from

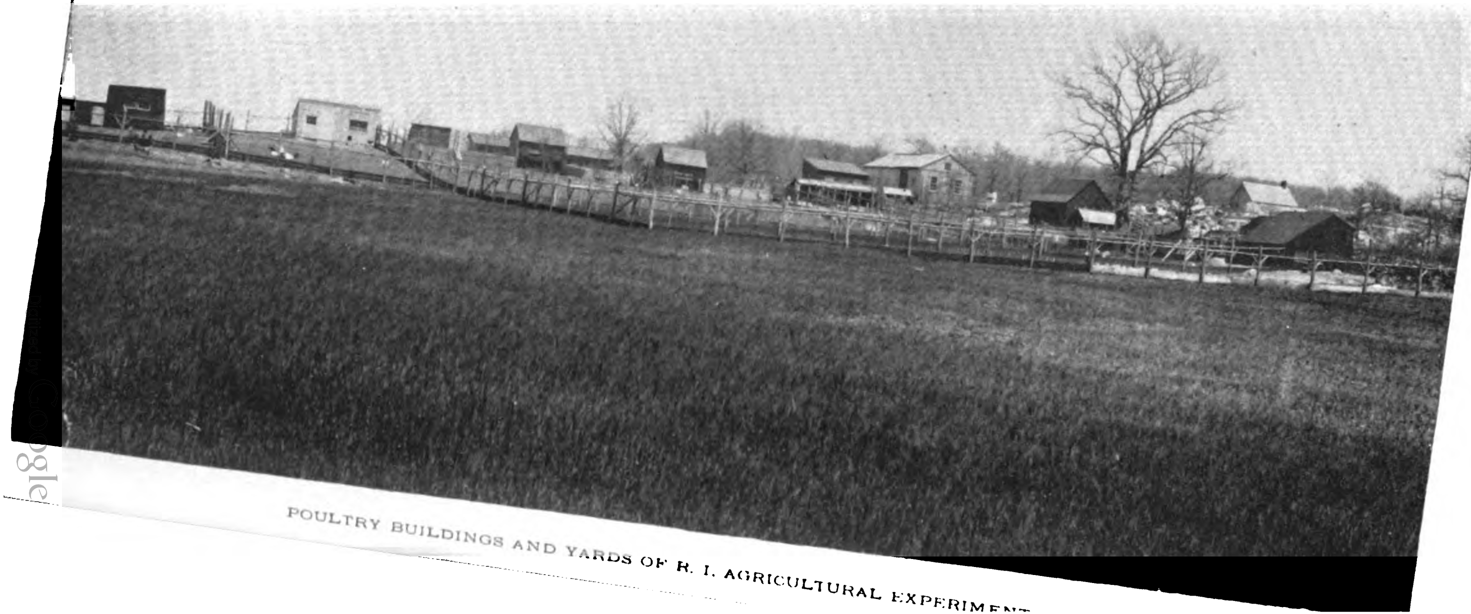
all parts of the country have visited its broiler houses that operations have been hindered and much loss has been caused so that now visitors are admitted to but very few places. Though many formerly engaged in this business here have located elsewhere, this place, with so many studying the problem and with so much available practical experience, is still a leading source of information regarding this line of work. We visited the place and saw several houses in operation and in one house, eighteen hundred chicks from two to four weeks old. We were informed that there were in this place 150 incubators in use. Here and in other Jersey towns much was learned that we shall endeavor to carry out in the work of this division.

A trip along the south shores of Long Island enabled us to see the methods followed by the most extensive duck raisers in this country. On these different farms we saw 1,000, 2,800, 3,200 and 4,000 young ducks from one to nine weeks old. From one small place in which $3,000 is invested and on which were 4,000 young ducks, 8,000 to 10,000 are marketed each season. The success of these operations and the necessity of artificial incubators and brooders for duck raising on an extensive scale, as well as for broiler rearing, was very apparent.

Visits made to duck farms in Massachusetts and to some of the large and successful egg farms in this State and New Hampshire have given us the plans on which they are conducted and much material for future work.

The result of our studies of the various buildings that we have seen and used in the past and have viewed on these trips may be seen in the Experiment Station poultry buildings. Among these is an Incubator House 12 x 18, built in a bank and, except at the west end, under ground to the eaves. The bottom of the excavation was dry and sandy and the sides were built of stone laid in cement. The room is double floored and sealed on both sides and overhead.

Double windows and doors and sawdust packing between the sides and above ceiling, protect the room from outside temperature. An under ground drain, 40 feet long, opening into the hillside, gives, when desired, fresh air of a modified temperature and with a roof ventilator, enables the operator to have as much or as little draft as is desired. Here are one 200 egg, and one 100 egg Prairie State Incubators, a hot air machine much used in New Jersey, and a "Monarch" hot water machine, 300 egg size. The latter is in use but is not owned by the Station. A "Challenge" hot water machine, 300 egg size is soon to be put in. In this room eggs for hatching, are also kept. For the double hot water brooder used the past season a small brooder house 8 x 8, covered with "Neponsett" was built. A building 12 x 14 that was used as a temporary office by the contractor of the school buildings and which stood near the Laboratory, was moved down the hill, covered with "Neponsett" paper and fitted for a poultry roosting and laying house. A building 12 x 18, built of the second hand lumber from the carpenter sheds is intended for the storage of sand, road dust, coops, &c., but a part has been partitioned off and is temporarily used as quarters for a breeding pen of fowls. A duck house, 6 x 10, with a low shed roof, a goose house 12 x 12, four shed roofed houses 6 x 10, built on runners, with four open sheds 4 x 10 to match, also on runners, and two double pitch roofed buildings, 6 x 10, with raised floor and 2 foot space or shed beneath, (also on runners that they may be readily drawn about the farm by a pair of horses) completes the list of buildings. A brooder house, 15 x 40, covered with "Neponsett," and a shed for turkeys is soon to be put up. In building we have endeavored to bring together as much as possible, the various models of the most practical poultry houses that may be built at a moderate cost. In putting our ideas into shape we have received invaluable assistance from the Agricultural School instructor in wood work, Mr. Thomas C. Rodman.



POULTRY BUILDINGS AND YARDS OF R. I. AGRICULTURAL EXPERIMENT

These buildings may be illustrated and more fully described in some future bulletin.

The illustration on the opposite page shows a view of the poultry buildings and yards from the south. At the right in the foreground is the house for geese, north of that the small duck house, while beyond the goose house and higher up may be seen the roof of the incubator building. To the left of the large tree are two houses, with open sheds in front, for breeding fowls. Between them and farther back is a long building, in the south end of which is the feed room, the other part now being used as the farm ice house. At the extreme left is one of the movable houses and sheds. At the right of this, the small permanent house and farther to the right, the two movable houses with shelters beneath. Back of these is the brooder house.

During the season, the capons and cockerels of the same lot, for comparison, as well as the geese and ducks, have been exhibited, with explanatory placards, at the Woonsocket and Kingston Fairs, at the State Fair and at the show of the Rhode Island Poultry Association. Much of this season's work has been to prepare for our principal experiment of next season, which will be to make a variety of first crosses for the production of the best market roasters and capons, their value as broilers and for egg production being a secondary consideration. We have procured for this purpose twelve varieties of pure bred fowls and have mated them with this end in view. Besides these birds we have one pair and one trio of imported Embden geese, nine fine Pekin ducks, two Pekin drakes and one pen of pure Light Brahma fowls. A few turkeys are soon to be added to the stock.

Visitors having a special interest in this line of work have been quite numerous and there evidently is a wide field of usefulness for such a division.

APICULTURAL DIVISION.

SAMUEL CUSHMAN.

The Apiary has the past season been run for surplus honey and only the most necessary care given it. The observatory hive was on exhibition through the season, many visitors were shown through the apiary and all possible aid and information given inquiring beekeepers. Sixteen hives of bees were brought through the winter and the same number put into winter quarters last fall. The season was a fair one especially for late honey and the quality of the surplus secured, both the extracted and comb honey, was as fine as we have ever had. This has been sold as usual, mostly to regular customers.

The experiments of the previous seasons would have been continued and new ones commenced had we not been obliged to be away so frequently on matters connected with the work of the new Poultry Division. In the future this division will probably receive, each season, its proper share of attention.

VETERINARY DIVISION.

FREDERICK E. RICE.

During the year I have been called upon to either give advice concerning, or to treat directly, 125 ailing animals. Of these 125 cases many have been of a kind requiring surgical operation and subsequent treatment. The greater portion of such cases I have been compelled to send away without surgical treatment; and this because of incomplete hospital outfit. For the same reason the clinics, which should have brought to the Station a large number of cases of all kinds, and so have greatly benefited the students of the State A. & M. School, as well as being of much good to owners, have brought but few cases; it having been generally understood throughout the State that the Station was not in readiness to receive cases requiring prolonged treatment. These facts have lessened the usefulness of the clinics and have prevented the students of the school becoming familiar with disease in animals.

The village being without a druggist, owners of animals were caused much inconvenience by reason of being compelled to drive some distance to get prescriptions compounded. To remove this inconvenience the Board of Managers supplied the division with drugs and with appliances for dispensing. This has increased the usefulness of the division and has already proved a great benefit to those presenting animals for treatment.

STUDY OF SPECIAL DISEASES.

During the early part of the year knowledge came to me that a disease affecting bovine animals and known as "The Gaunts" has

annually invaded the herds of what is known as the "back side district" (along the shore west of Point Judith pond). As this disease was brought to my notice when my duties in the school were taking the greater part of my time, and as the season of the annual prevalence of the disease had nearly or quite passed before I had opportunity of visiting the district, I have been prevented doing more than recording the statements of owners concerning the course, symptoms, and supposed cause of the trouble. The facts at present in my possession hardly warrant an opinion as to the real nature of the disease; but certain facts indicate that it is a local trouble and not transmissible.

During the coming season this disease will be given special attention, and I hope to be able to publish a bulletin outlining the affected district, and giving, if not the nature and cause of the disease, such an analysis of cases and of the character of the soil, water, forage plants, etc., of the affected district as will furnish data for an intelligent study of the trouble together with suggestions as to means of lessening its activity.

DISEASE AMONG TURKEYS.

During later years an obscure disease has prevailed to such an extent among the turkeys of the State as to not only cause serious loss to owners but to threaten the slow, but not the less certain, extermination of this source of income to our citizens. The disease appears about the head of the turkey as a small spot of discoloration; this spreads rapidly to adjacent parts, and in a few days the bird dies. The general belief among owners is that the disease is infectious; but whether this is true is a question that requires more evidence for its answering. This disease is being studied and I shall be thankful if those owning affected birds will give me notice of the existence of the disease, or in event of birds dying, if they will forward the carcass to the Station at Kingston.

TUBERCULOSIS OR CONSUMPTION.

The almost immediate connection between bovine and human tuberculosis, and the many questions as to its transmissibility which are either unanswered or so answered as to demand the evidence of repeated experiment that convincing proof may be given, render investigations in this disease of special interest and importance. The Station is provided with a building set apart for animals used in these investigations; and experiments are now being conducted which, it is hoped, will increase our knowledge of the nature of this disease and of means calculated to more certainly prevent its spread among our herds and render the food-products of tuberculous animals innocuous when unwittingly consumed by man.

In this connection I beg to submit the question as to the desirability of the Veterinary Division undertaking to furnish sterilized milk to the people of this and the surrounding towns. The proximity of the Station to Narragansett Pier, where during the summer many infants are congregated, together with the general demand throughout the State for this article—recognized by physicians as absolutely necessary to the successful treatment of infantile indigestion—would, it seems to me, warrant the undertaking of a work that would be highly appreciated by the public.

METEOROLOGICAL SUMMARY.

JANUARY 1ST TO JULY 1ST, 1891. RECORDS MADE DAILY AT 7 A. M., 2 P. M. AND 9 P. M.*

L. F. KINNEY.

	January.		February.		March.		April.			May.			June.		
	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1889.	1891.	1890.	1889.	1891.	1890.	1889.
Highest Barometer	30.45	30.56	30.48	30.40	30.52	30.35	30.52	30.33	....	30.47	30.17	30.50	30.16	30.20	30.38
Lowest Barometer	28.74	29.25	29.21	29.25	29.51	29.25	28.94	29.30	....	29.68	29.53	29.40	29.62	29.67	29.10
Mean Barometer	29.858	29.84	30.079	29.86	30.095	29.79	29.875	29.86	....	29.951	29.85	29.87	29.899	29.89	29.94
Highest Temperature	59.°	63.°	58.°	64.°	59.°	67.°	76.°	70.°	71.°	79.°	77.°	88.°	92.°	86.°	87.°
Lowest Temperature	12.°	8.°	5.°	10.°	1.°	5.°	20.°	24.°	26.°	30.°	36.°	35.°	42.°	54.°	42.°
Mean Temperature	31.5°	36.4°	32.1°	35.2°	32.8°	33.5°	44.9°	44.7°	45.9°	53.1°	54.1°	56.6°	63.6°	63.9°	64.49°
Mean Humidity	.876	.829	.854	.791	.821	.709	.742	.686	.760	.723	.821	.866	.779	.800	.907
Prevailing Winds	S. W.	N. W.	S. W.	N. W.	N. W.	N. W.	S. W.	S. W.	N. E.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.
Total Rain and Melted Snow	7.31 in.	3.02 in.	7.26 in.	3.30 in.	7.97 in.	9.83 in.	4.70 in.	4 27 in.	4.20 in.	1.76 in.	4.72 in.	3.58 in.	.70 in.	3.98 in.	3.66 in.
No. of days on which the cloudiness averaged 8 or more on a scale of 10	15	15	11	14	7	10	4	5	7	5	9	6	7	10	14
No. of days on which the cloudiness averaged 3 or less on a scale of 10	4	8	2	7	14	4	15	11	8	14	10	5	13	10	8
No. of days on which .01 of an inch or more of Rain fell	9	11	6	13	5	16	8	10	9	5	11	6	3	8	6

* Barometric readings reduced to the sea level and a temperature of 32° F. after January 1st, 1891.

METEOROLOGICAL SUMMARY.

JULY 1ST TO OCTOBER 1ST, 1891. RECORDS MADE DAILY AT 7 A. M., 2 P. M., AND 9 P. M.*

L. F. KINNEY.

	July.			August.			September.		
	1891.	1890.	1889.	1891.	1890.	1889.	1891.	1890.	1889.
Highest Barometer	30.35	30.20	30.25	30.22	....	30.25	30.36	30.25	30.25
Lowest Barometer	29.70	29.69	29.69	29.95	....	29.63	29.67	29.55	29.35
Mean Barometer	29.896	29.962	29.928	29.63	....	30.02	30.084	30.01	29.952
Highest Temperature	88.°	92.°	86.°	91.°	85.°	82.°	82.°	80.°	80.°
Lowest Temperature	49.°	47.°	51.°	48.°	38.°	49.°	48.°	34.°	36.°
Mean Temperature	65.6°	69.10°	67.7°	69 3°	66.9°	66.1°	64 3°	61.4°	61.5°
Mean Humidity	.825	.775	.874	.849	.805	.845	.851	.824	.906
Prevailing Winds	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.
Total Rain and Melted Snow	2.11 in.	1.88 in.	8.30 in.	2.69 in.	3.89 in.	4.17 in.	2.20 in.	3.93 in.	4.61 in.
No. of days on which the cloudiness averaged 8 or more on a scale of 10	12	5	12	5	10	9	3	14	13
No. of days on which the cloudiness averaged 3 or less on a scale of 10	11	9	10	6	2	10	9	9	7
No. of days on which .01 of an inch or more of Rain fell	6	7	15	10	9	5	6	10	9

* Barometric readings reduced to sea level and a temperature of 32° F. after January 1st, 1891.

METEOROLOGICAL SUMMARY.

October 1st, 1891, to January 1st, 1892. Records Made Daily at 7 A. M., 2 P. M. and 9 P. M.*

L. F. Kinney.

	October.			November.			December.		
	1891.	1890.	1889.	1891.	1890.	1889.	1891.	1890.	1889.
Highest Barometer	30.51	30.19	30.25	30.71	30.12	30.75	30.46	30.44	30.60
Lowest Barometer	29.48	29.12	29.57	29.48	29.15	29.20	29.34	29.27	29.40
Mean Barometer	29.986	29.73	29.875	30.117	29.78	29.857	30.053	29.868	29.896
Highest Temperature	78.°	75.°	71.°	62.°	67.°	62.°	65.°	52.°	61.°
Lowest Temperature	20.°	32.°	30.°	9.°	14.°	17.°	7.°	1.°	12.°
Mean Temperature	49.7°	49.8°	49.2°	40.3°	41.3°	43.5°	39.5°	27.3°	38.4°
Mean Humidity	.822	.779	.875	.796	.825	.872	.753	.857	.875
Prevailing Winds	S. W.	N. E.	S. W.	S. W.	S. W.	S. W.	S. W.	N. W.	W.
Total Rain and Melted Snow	6.22 in.	9.43 in.	3.02 in.	2.99 in.	.96 in.	7.52 in.	3.73 in.	4.71 in.	2.76 in.
No. of Days on which the cloudiness averaged 8 or more on a scale of 10	8	15	11	10	5	12	8	10	9
No. of Days on which the cloudiness averaged 3 or less on a scale of 10	9	6	10	10	11	6	9	12	7
No. of Days on which .01 of an inch or more of Rain fell	7	16	10	8	3	11	10	6	12

* Barometric readings reduced to the sea level and a temperature of 32° F. after January 1st, 1891.

REPORT OF THE TREASURER.

The Rhode Island State Agricultural Experiment Station in account with the United States Appropriation.

DR.

1891.	To receipts from Treasurer of the United States as per appropriation for year ending June 30, 1891, under Act of Congress approved March 2, 1887		$15,000 00

CR.

June 30.	By Salaries	$5,508 61	
	Labor	3,974 79	
	Supplies and repairs	2,023 41	
	Freight and express	724 84	
	Library and printing	978 40	
	Tools and machinery	593 66	
	Scientific instruments	148 26	
	Chemical apparatus and supplies	293 76	
	Live stock	288 00	
	Travelling	349 05	
	Incidentals	117 22	
		$15,000 00	$15,000 00

This certifies that we, the undersigned, authorized Auditing Committee of the Board of Managers of the Rhode Island State Agricultural School and Experiment Station, have examined the accounts of the Treasurer of the Agricultural Experiment Station for the fiscal year ending June 30, 1891, and that we find the receipts for the time named to have been $15,000, and that the same has been expended, for which satisfactory vouchers, correctly classified

as above, are on file, and the same agrees with the Treasurer's account, and that there is no unexpended balance.

CHARLES J. GREENE,
CHAS. O. FLAGG,
Auditing Committee.

I hereby certify that the above statement is a true copy from the books of account of the Institution named.

MELVILLE BULL,
Treasurer of the Rhode Island State Agricultural School and Experiment Station.

I hereby certify that the above signature is that of the Treasurer of the Rhode Island State Agricultural School and Experiment Station.

CHARLES O. FLAGG,
President Board of Managers Rhode Island State Agricultural School and Experiment Station.

Melville Bull, Treasurer, in account with the Rhode Island State Agricultural Experiment Station.

DR.

1891.		
June 30.	To balance on hand June 30, 1890	$983 77
	" receipts from farm	1,287 12
	" " interest	209 82
		$2,480 71

CR.

1891.		
June 30.	By Buildings	$141 10
	" Furniture	1,654 78
	" Roads and water supply	388 66
	" Chemical apparatus and supplies	296 17
		$2,480 71

DR.

1890.		
May 24.	To receipts from Treasurer of the United States, as per appropriation made by Special Act of Congress on April 4, 1890	$15,000 00

CR.

1891.		
June 30.	By Salaries	$855 23
	" Labor	1,451 39
	" Supplies and repairs	1,385 72
	" Library and printing	288 42
	" Tools and machinery	30 05
	" Live stock	75 00
	" Travelling	48 74
	" Incidentals	412 54
	" Buildings	750 00
		$5,297 09
	Balance unexpended	9,702 91

KINGSTON, Oct. 30, 1891.

THIS IS TO CERTIFY that the undersigned, Auditing Committee of the Board of Managers of the Rhode Island State Agricultural Experiment Station have examined the accounts of Melville Bull, Treasurer, ending June 30, 1891, and the vouchers corresponding therewith and find the same correct.

CHAS. J. GREENE,
CHAS. O. FLAGG.

DONATIONS.

From Secretary of Agriculture, Hon. J. M. Rusk, and from the Department of Agriculture have been received the following reports and publications: *Report of the Secretary of Agriculture for 1890.* Bound copy of *Experiment Station Record, Vol. 1, Sept. 1889—July, 1890. Swine Plague and Special Report on Diseases of the Horse*, Bureau of Animal Industry. *Reports* from the *Statistician*, *Reports* of the *Entomologist*, from the *Division of Vegetable Pathology.* The *Experiment Station Record and Bulletins*, *Reports from the Division of Botany*, *Division of Chemistry and miscellaneous bulletins.* From the Bureau of Education, Dept. of the Interior, *Higher Education in Indiana*, and from the Census Office a nearly complete set of *Census Bulletins. Special Report* of the Chief of the Weather Bureau to the Sec'y. of Agriculture, from Mark W. Harrrington, Chief of Weather Bureau, and *Monthly Weather Review. Album of Agricultural Graphics* from the Secretary of Agriculture.

The following State Reports and Publications have been received, viz.: *Twenty-four Volumes of the Reports of the Commissioner of Public Schools*, together with the *Report of the Board of Education*, presented by Commissioner Stockwell. *Twenty-Second Annual Report of the Board of State Charities and Corrections of Rhode Island, for 1890*, Wm. W. Chapin, Secretary. *Sixth Annual Report of the State Board of Agriculture*, David S. Collins, Secretary. One large *Topographical Map of Rhode Island*, presented by Commissioner Stockwell.

Annual Report of the Secretary of the State Board of Agriculture of Colorado, 1890. Thirty-Eighth Annual Report of the Secretary of the Massachusetts Board of Agriculture, from Wm. R. Sessions, Secretary. Also, from the same source, a pamphlet on *Insecticides and their Application. Seventeenth Annual Report of the Ontario Agricultural College and Experiment Farm*, from Pres. James Mills. *Twenty-Fourth Annual Report of the Secretary of the Connecticut Board of Agriculture, 1890*, T. S. Gold, Secretary. Pamphlet on *Sorghum as a Sugar Plant for Lower Louisiana*, sent by W. J. Thompson. *Hand Book of the American Republics, Nos. 1, 2, 5, 7 and 9*, from Bureau of American Republics, Washington, D. C. *Second Annual Report of the Missouri Botanical Garden*, Wm. Trelease, Director. *Thirty-Third Annual Report of the Missouri State Horticultural Society*, L. A. Goodman, Secretary. *Second Biennial Report of Kansas Horticultural Society for 1889-90*, G. G. Bracket, Secretary. Pamphlet of the *List of Flowering and Fern Plants of Lorain Co., O.*, presented by Azariah Root, Librarian of Oberlin College. *Annual Report of the Department of Agriculture*, 1890, Ontario, C. C. James, Secretary. *Agricultural Gazette*, of New South Wales, volume 2, 8 numbers, from Director H. C. L. Anderson. *Annual Report of the Department of Agriculture for the years 1889-90*, Queensland, Australia, Hon. Peter McLean, under Secretary for Agriculture. Six *Annual Reports of the Board of Control, of the New York State Experiment Station*, Dr. Peter Collier, Director. *Seventh Annual Report of the New York State Dairy Commissioner*. Book on *Cattle Breeding*, by Warfield, presented by J. D. Towar. One *Chart*, presented by Dr. Peter Collier, Geneva, N. Y.

Thos. B. Wales, Secretary, Holstein Friesian Herd Book, Boston, Mass., 12 vols. *Holstein Friesian Herd Book*, also 9 vols. *Holstein Herd Book*, and 3 vols. *Dutch Friesian Herd Book;* from S. Hoxie, Yorkville, N. Y., Supt., 3 volumes *Holstein Friesian Ad-*

vanced Register; from H. B. Richards, Secretary, 3 vols. *Dutch Belted Cattle Herd Book;* from H. B. McDowell, Secretary, Canton, Ohio, 1 vol. *National Dickinson Spanish Sheep Register;* from N. R. Pike, Secretary, 5 vols. *Herd Book Maine State Jersey Cattle Association;* from D. R. Button, Secretary, Cheshire Swine Breeders Association, Vol. 1, *Cheshire Herd Book;* from E. N. Ball, Secretary, 3 vols. of the *Register of the Michigan Merino Sheep Breeders Association;* from Geo. F. Davis, Secretary, vol. 1 of *Victoria Swine Record;* from Geo. Hammond, Secretary, Middlebury, Vermont, The *Register of the Vermont Atwood Merino Sheep Club;* from J. McLain Smith, Secretary, Farmington, Conn., 3 vols. *Guernsey Herd Register;* from Carl Freigau, Dayton, O., 4 vols. *Chester White Record* and Vol. 10 of *Poland China Record;* from Mortimer Levering, LaFayette, Ind., *American Shropshire Record* complete. *Thirteenth Annual Report of the Providence Public Library*, Wm. E. Foster, Librarian.

Five Pamphlets, from George W. Rafter, Rochester, N. Y., viz.: "*Biological Examination of Potable Water.*" "*Filtration of Sewage.*" "*From Proceedings of American Society of Microscopists*, 1889." "*On the Micro-Organisms in Hemlock Water.*" "*Report on an Endemic of Typhoid Fever.*" *Annual Report* of the Trustees of the Storrs' Agricultural School at Mansfield, Conn. *Report* of the Surveyor General and State Land Register of the State of Nevada, 1889-90. *First Biennial Report*, from the Bureau of Mines, Manufactures and Agriculture of the State of Arkansas, for the years 1889-90, M. F. Locke, Commissioner. *Three Pamphlets or Bulletins*, from the State Board of Horticulture, San Francisco, Cal.,—viz.: *The Orange "from Seed to Grove." Internal Parasites discovered in the San Gabriel Valley, Recommendations and Notes. Peach Tree Borers infesting Deciduous Fruit Trees. Annual Report and Catalogue of the Hampton Institute*, Hampton, Va. *Annual Reports* and *Bulletins* of all the Experiment Stations.

NEWSPAPER EXCHANGES.

The Baltimore Sun, Baltimore, Md.
Mirror and Farmer, Manchester, N. H.
Boston Weekly Globe, Boston, Mass.
The National Provisioner, New York, N. Y.
The American Homestead, Omaha, Neb.
The Holstein Friesian Register, Boston, Mass.
The Toledo News, Toledo, Ohio.
The Industrial American, Lexington, Ky.
The Practical Farmer, Philadelphia, Penn.
The American Agriculturist, New York, N. Y.
The Louisiana Planter, New Orleans, La.
The Southern Cultivator and Dixie Farmer, Atlanta, Ga.
The Sugar Beet, Philadelphia, Penn.
Home and Farm, Louisville, Ky.
The Pomona Herald, Providence, R, I.
Sentinel and Advertiser, Hope Valley, R. I.
Horticultural Art Journal, Rochester, N. Y.
Industrial News, Toledo, Ohio.
The New Dairy, New York, N. Y.
Hospodar, (*Bohemian*), Omaha, Neb.
The University Record, Ann Arbor, Mich.
The Naturalist's Leisure Hour, Philadelphia, Pa.
The Agricultural Epitomist, Indianapolis, Ind.

CURIOSITIES.

Shoe covered with oyster shells and specimen of *natural grafting in a large apple tree root*, from Chas. T. Maxfield, Oakland Beach.

HORTICULTURAL DIVISION.

Francis Brill, Hempsted, N. Y, *cabbage and cauliflower*. C. E. Cole, Buckner, Mo., *seeds*. Joseph Harris Seed Co., Rochester,

N. Y., *seeds*. Department of Agriculture, Washington, D. C., *willow rods*. Department of Agriculture, Washington, D. C., *apple and pear scions*. Mrs. R. Hazard, Peace Dale, R. I., *collection of California seeds*. Nathan D. Pierce, Jr., Norwood, R. I., *seeds*. Kirkwood, Miller & Co., Peoria, Ill., "Success" Garden Cultivator. James Nisbet, Pawtucket, R. I., *collection of plants and bulbs*. J. Erastus Lester, Providence, R. I., *seeds and scions*. Jerome Rice & Co., Cambridge, N. Y., *seeds*. Steele Brothers & Co., Toronto, Ontario, *seeds*. W. S. Powell & Co., Baltimore, Md., *fungicides*.

INDEX

TO THE

BULLETINS AND ANNUAL REPORT PUBLISHED BY THE R. I. STATE AGRICULTURAL SCHOOL AND EXPERIMENT STATION.

1891.

INDEX TO BULLETIN NO. 10. MAY, 1891, PART 1.

INDEX TO BULLETIN NO. 12. AUGUST, 1891.

INDEX TO BULLETIN NO. 13. SEPTEMBER, 1891.

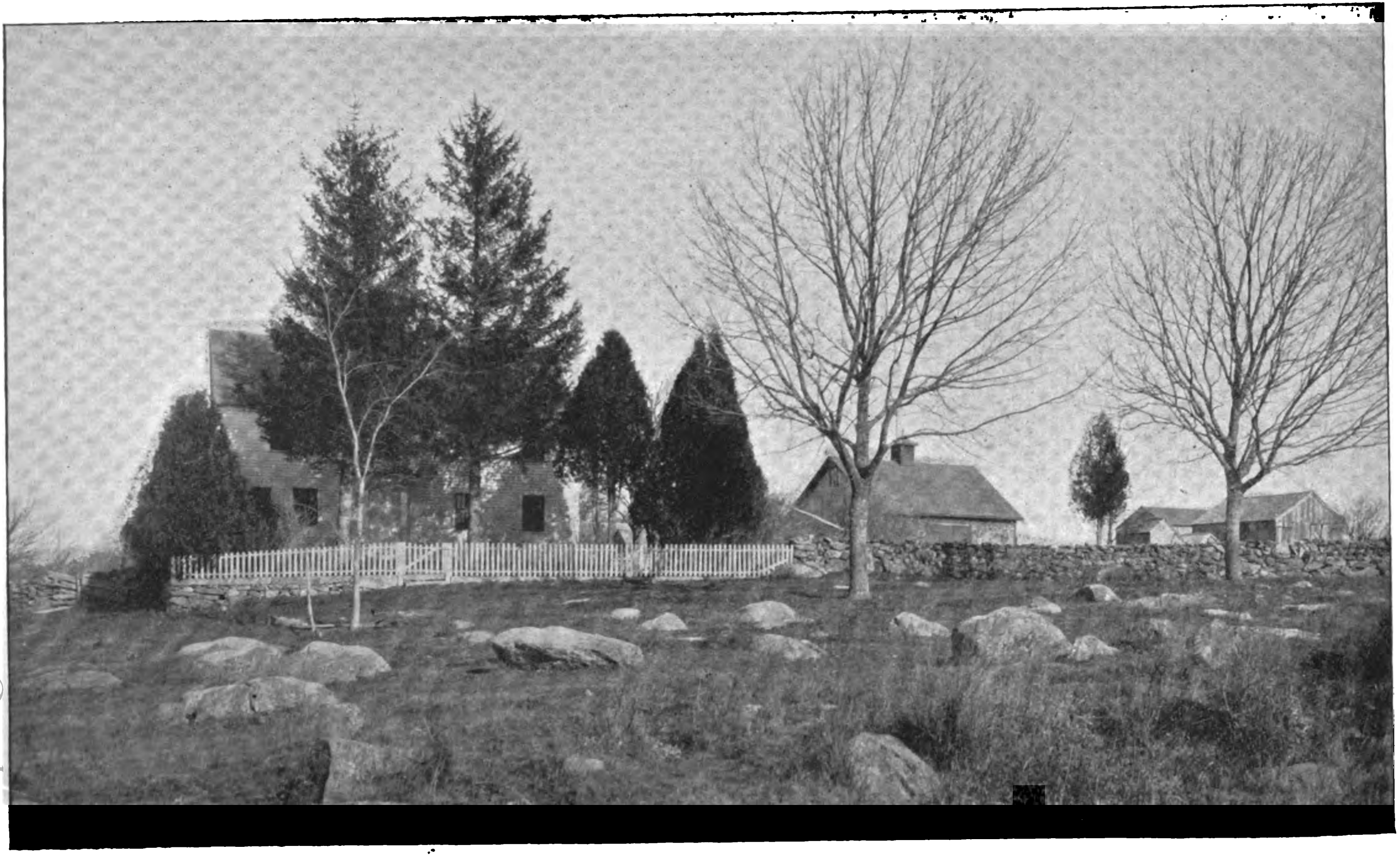
INDEX TO BULLETIN NO. 14. OCTOBER, 1891.

INDEX TO FOURTH ANNUAL RRPORT.

Part I. State Agricultural School.

Index to Fourth Annual Report, 1892.

Part II. State Agricultural Experiment Station.



VIEW OF EXPERIMENT STATION FARM BUILDINGS WHEN PURCHASED, 1889.

State of Rhode Island and Providence Plantations.

FIFTH ANNUAL REPORT

OF THE

BOARD OF MANAGERS

OF THE

Rhode Island College of Agriculture and Mechanic Arts,

MADE TO THE

GENERAL ASSEMBLY AT ITS JANUARY SESSION, 1893.

PART II.

AGRICULTURAL EXPERIMENT STATION,

(PART I.—College of Agriculture and Mechanic Arts—is printed under separate cover.)

PROVIDENCE:
E. L. FREEMAN & SON, STATE PRINTERS.
1893.

BOARD OF MANAGERS

OF THE

RHODE ISLAND

COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

MELVILLE BULL, - - - - - -	Newport County.
C. H. COGGESHALL, - - - - -	Bristol County.
CHAS. O. FLAGG, - - - - - -	Providence County.
NATHAN D. PIERCE, JR., - - - -	Kent County.
CHAS. J. GREENE, - - - - -	Washington County.

OFFICERS OF THE BOARD.

CHAS. O. FLAGG, President, - -	P. O., Kingston, R. I.
CHAS. J. GREENE, Clerk, - - -	P. O., Kenyon, R. I.
MELVILLE BULL, Treasurer, - -	P. O., Newport, R. I.

EXPERIMENT STATION STAFF.

CHAS. O. FLAGG, B. Sc., - -	Director and Agriculturist.
L. F. KINNEY, B. Sc., - - - - -	Horticulturist.
H. J. WHEELER, Ph. D., - - - - - -	Chemist.
SAMUEL CUSHMAN, - -	Apiarist and Poultry Manager.
J. D. TOWAR, B. Sc., - - - -	Assistant Agriculturist.
B. L. HARTWELL, B. Sc., - - - -	Assistant Chemist.
H. F. ADAMS, - - - - - - - -	Farmer.
MISS A. R. FRENCH, - - - - - - -	Clerk.

The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office, Kingston, Rhode Island.

LETTER OF SUBMITTAL.

To His Excellency, D. Russell Brown, Governor, and the Honorable the General Assembly of the State of Rhode Island at its January Session, 1893.

KINGSTON, January 31st.

I have the pleasure to present herewith in compliance with the statute of the State and the Congressional act of March 2, 1887, the report of the Director and the heads of the various Divisions of the Rhode Island Agricultural Experiment Station, together with that portion of the report of the Treasurer of the Board of Managers of the R. I. College of Agriculture and Mechanic Arts relating exclusively to the Experiment Station.

Respectfully submitted,

For the Board of Managers,

CHAS. O. FLAGG,

President.

REPORT OF THE DIRECTOR.

CHAS. O. FLAGG.

The Station Staff, divisions and arrangement of work have continued throughout the year as previously organized with the exception that the Station has had no Veterinarian since July 1st, the College having found it necessary, for financial reasons, to terminate its engagement with Dr. F. E. Rice at that time.

LEGISLATION AFFECTING THE STATION.

The passage of a new fertilizer law on April 20, 1892, has made possible a much more thorough and efficient inspection and control of the fertilizers offered for sale within the State than heretofore. The new law—Chapter 1055 of the Public Laws*—places the authority of the fertilizer inspection in the hands of the State Board of Agriculture, and the Secretary of that Board is made the prosecuting officer in cases of violation of the law. The Chemist of this Station or his deputy is authorized to collect the samples and make the analyses, and the Director to publish the results in the form of bulletins for distribution. The General Treasurer secures all analysis fees and issues all licenses. The money so received is used to defray the expenses of the inspection, all bills being first approved by the Board of Agriculture and the Governor. Further reference to this subject will be found in the report of the Chemist, Dr. H. J. Wheeler.

* Published in Bul. No. 16 of this Station, page 31.

On May 19th, Chapter 1082 of the Public Laws was passed. This is a law reorganizing the State Board of Agriculture and making an appropriation for the holding of agricultural institutes and the control of contagious diseases of domestic animals. It provided that the Board of Managers of the Rhode Island College of Agriculture and Mechanic Arts should appoint one member from its board who should be a member of the Board of Agriculture, and also increased the membership by adding a representative from the Order of Patrons of Husbandry with the view of bringing into closer relationship the agricultural interests, and those interested in their development, within the State. At a meeting held May 20th the Director was appointed a member of the Board of Agriculture for the term of one year as provided in the law, and in that capacity has endeavored to do whatever was required to promote and build up Rhode Island agriculture.

On the same day, May 19th, the Act—Chapter 1078 of the Public Laws*—was passed creating the State Agricultural School a *College of Agriculture and Mechanic Arts* and connecting with it the Experiment Station. This did not at all change the relation of the Station to the educational side of the institution but as changes were necessary in the course of study, in making a "School" course of three years, into a College course of four years, and as several members of the Station Staff do more or less teaching, and as more teaching is required with four classes than three, the ultimate result will be to considerably increase the college duties of certain members of the Staff. This, however, is a matter for the Board of Managers to adjust in the relation that exists between the College and Station.

PUBLICATIONS.

The following bulletins have been issued. From 4500 to 5500 copies of each number have been printed and comparatively few are now on hand. While the supply lasts, copies of any particu-

* Printed on page 12 of Part 1 of the Fifth Annual Report.

lar number or of all will be sent "to such individuals actually engaged in farming as may request the same." The bulletins are numbered consecutively in the order of their issue, but paged from the beginning of each year; the paging will continue through the annual report and one index at the close of the year will cover all the publications issued during that time. In this way all who desire to preserve the publications of the Station in a permanent form can have bulletins and report of each year bound together in one volume with an index for convenient reference.

BULLETIN NO. 15. APRIL, 1892.

BY CHAS. O. FLAGG AND L. F. KINNEY.

CONTENTS.

TREATMENT OF LOOSE SMUT OF OATS.
FUNGICIDES AND INSECTICIDES AND APPARATUS FOR APPLYING THEM.
BLACK ROT OF THE GRAPE AND APPLE SCAB.
CODLING MOTH, CANKERWORM AND PLUM CURCULIO.

BULLETIN NO. 16. MAY, 1892.

BY H. J. WHEELER AND B. L. HARTWELL.

CONTENTS.

1. THE NEW FERTILIZER LAW FOR RHODE ISLAND.
2. SELLING PRICE OF FERTILIZER STOCK.
3. ANALYSES OF COMMERCIAL FERTILIZERS, STATE INSPECTION, 1892.
4. MISCELLANEOUS ANALYSES.

BULLETIN NO. 17. JUNE, 1892.

BY H. J. WHEELER AND B. L. HARTWELL.

CONTENTS.

ANALYSES OF COMMERCIAL FERTILIZERS, STATE INSPECTION, 1892.

BULLETIN NO. 18. AUGUST, 1892.

BY H. J. WHEELER AND B. L. HARTWELL.

CONTENTS.

ANALYSES OF COMMERCIAL FERTILIZERS, STATE INSPECTION, 1892.
A WORD OF CAUTION IN THE PURCHASE OF WOOD ASHES.

BULLETIN NO. 19. SEPTEMBER, 1892.

By H. J. Wheeler and B L. Hartwell.

CONTENTS.

Concluded List of Fertilizer Analyses, State Inspection, 1892, with Summaries and Comments.

BULLETIN NO. 20. DECEMBER, 1892.

By Samuel Cushman.

CONTENTS.

The Production of Capons.

Experiments in Caponizing.

Prices of Capons, Broilers, Roasters and Fowls in Boston and New York Markets.

When to make Capons, the Time to Sell and how to Prepare for Market.

Caponizing Tools and how to Perform the Operation.

TEMPERATURE AND RAINFALL.

The following table gives the mean temperature and total fall of rain and melted snow for the past three years.

MEAN TEMPERATURE.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Average.
1890........	36 4	35.2	33.5	44.7	54.1	63.9	69.1	66.9	61.4	49.3	41.3	27.3	48.63
1891...	31.5	32.1	32.8	44.9	53.1	63.6	65.6	69.3	64.3	49.7	40 3	39.5	48.92
1892........	29.0	29.2	32.7	45.3	53.6	65.6	70.4	68.4	60.4	50.3	40.2	28.8	47.83

TOTAL RAINFALL AND MELTED SNOW.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Yearly Average.
1890	3.02	3.30	9.83	4.74	4.70	3.98	1.88	3.89	3.93	9.43	.96	5.51	55.17	4.59
1891	7.31	7 26	7.97	4.70	1.76	.70	2.11	2.69	2.20	6.22	2.99	3.73	49 64	4.136
1892	5.39	1.72	4.09	3.20	6.09	1.61	3.43	2.96	2.48	1.64	6.20	2.02	40.83	3.402

The mean temperature was 1.09° lower in 1892 than in 1891, and the lowest of the three years. The first two months of the year were respectively 2° and 3° colder than the same months of 1891. March varied on the average but one-tenth of a degree; April and May were each a fraction of a degree warmer and the difference was increased in June to 2°, while July was the hottest of the three years,—4.8° warmer than 1891 and 1.3° warmer than 1890. During the remainder of the year the principal difference was in September and December, both months averaging colder than the previous year; in the latter, the difference was particularly noticeable, being 10.7° colder.

There was quite a decrease in the total rainfall during the year, 8.81 inches, including melted snow, or 14.14 inches decrease in three years. The first four months were dryer, particularly February, 7.26 inches falling in 1890 and but 1.72 inches in 1892. May was a wet month compared with 1891—6.09 inches of rain falling, and June, also, though the rainfall was small, gave more than twice as much as the previous year; July was wettest of the three years but the rainfall, 3.43 inches, was not excessive. August and September varied in rainfall but little. October was especially dry, only 1.64 inches of rain fell as against 6.22 in 1891 and 9.43 in 1892. November went to the opposite extreme, 6.20 inches of rain falling the past year, and December gave less than either of the previous years.

The following table gives the number of *clear*, *fair* and cloudy

days, also the number of days on which more than one-tenth of an inch of rain fell—the latter of course being included in the number of *cloudy* days.

The day is called *clear* when less than one-tenth of the sky is overcast with clouds at each of the three observations, or less than 3 out of 30 tenths. *Fair* is from 10 to 21 tenths cloudy, and *cloudy* is from 22 to 30 tenths covered with clouds.

1892.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
Clear.......	9	11	14	16	10	9	15	11	18	14	9	11	147
Fair........	10	6	6	4	13	10	9	13	9	12	13	11	116
Cloudy.....	12	12	11	10	8	11	7	7	3	5	8	9	103
Rain.......	10	5	6	7	14	6	9	6	5	5	7	9	89

The season was generally favorable for crops. Grass did not produce so heavy a crop of hay as usual, but was mainly secured in good condition. Corn yielded well and freedom from early frosts allowed even the latest planted to ripen thoroughly. Potatoes gave a more than average yield in many places for the early planted crops and the rot was not so destructive as in some years. Small fruits were fairly productive excepting raspberries, which were almost universally winter-killed. There was a medium crop of apples and pears.

Chemical Division. The passage of the revised fertilizer law last spring made possible a much more thorough inspection of the fertilizer trade than has been made in any previous year. The new law makes it the duty of the station chemist or his deputy to collect a sample of all fertilizers sold or offered for sale within the state and analyze the same. The past year 103 distinct brands of fertilizer have been analyzed and the results published in bulletins by order of the Director as the law provided.

A thorough investigation of the value, from a chemical standpoint, of the sea-weed usually found on our coast is being made, which we believe will be of value to all our coast farmers and wherever sea-weed is used as manure. An increased amount of work has been done in the making of analyses of miscellaneous materials from various sources as well as considerable chemical work for the apicultural and poultry divisions. The analysis of the eight samples of soil from different parts of the state as prepared for the World's Columbian Exposition has required a large amount of labor. Valuable assistance has been given by the chemist in planning the agricultural field work and in furnishing special formulas for home-mixed fertilizers.

The laboratory is well provided with apparatus, but more room would be a great advantage and facilitate the work. To provide the large amount of distilled water necessary, a block tin still heated by gas has been provided during the year.

Horticultural Division. The young trees have made a steady and satisfactory growth. None have yet reached a bearing age. The vineyard has been materially enlarged and a valuable collection of trees and shrubs set upon the college grounds, which in general have made satisfactory growth. The large number of varieties of strawberries fruited last summer has furnished considerable data for a bulletin upon the subject of the cultivation of this valuable fruit. Considerable work has been done in the way of gathering seeds of our native plants for a permanent collection and in treating various fungous diseases and insect pests. A temporary propagating pit was constructed three years ago of regular hotbed sash, using a car heater for a boiler. The latter became unserviceable; the sash never made a desirable roof, and this fall a regular glazed roof with greater pitch was constructed and a regular pattern of greenhouse boiler secured for heating. The sash are used for hot-bed and cold frame work.

Apiary. There has been no experimental work in the apiary. The 16 colonies have been well cared for and run for honey

production. The season has been a good one as 839 pounds of extracted and 87 pounds of comb honey have been secured, and the bees were well provided with winter stores. The 16 colonies were increased to 18 during the season.

Poultry Division. The scope of this Division has been considerably enlarged during this season. A hot water incubator has been added to the two hot air machines previously used and a "brooder house" heated with hot water provided for the chicks. Considerable work has been done in the production of first crosses from pure bred fowls with the object of finding, if possible, which would make the best and most profitable market poultry. Work will be continued with these crosses another year for further results. The subject of turkey raising has had some attention and a *pure wild gobbler* secured for additional experiments in crossing. The subject of caponizing has received careful study for two seasons and the results are given at length in Bulletin No. 20.

Agricultural Division. The coöperative field experiments have been continued at the Station and one acre each in Westerly, Hope Valley, Summit, Noose Neck and Abbott Run, in charge of my assistant, J. D. Towar, B. Sc. Other experiments in this division at the Station have been along the following lines:—Winter and spring application of ashes to grass. Shrinkage in two varieties of corn. Oats the second year on field manured with sea-weed. Test of varieties of oats. Treatment of oats by the Jensen method for the prevention of smut. Cultivation of permanent plots and yield of corn without fertilizer or manure. Growth of corn the second year upon field fertilized with equal and proportional values of stable manure, fertilizer and chemicals in 1891—with the addition this season of phosphoric acid and lime. The use of air slacked lime in connection with sulphate of ammonia and other chemicals. A test of phosphates alone for corn, six plots on the plain and duplicates on the heavy soil of the hill. Growing of soja beans and cow peas for fodder and cow

peas for green manuring. A test of varieties of rye. Benefit of lime on grass and a test in the school garden of varieties of melons.

The above work has required the use of 299 plots, about one-half of which have been of 1-10 acre or more in extent and most of the remainder 1-20 acre in area.

Permanent Plots. The area to be devoted to permanent plot experiments has been about doubled and the ground plowed. Some 40 plots have been planted this year with corn without manure for the purpose of securing a record of the natural fertility of the soil. No good corn was produced. Much of the corn would not average over 30 inches in height at the time of harvest and no ears worth husking. The remainder of the field will be planted the coming season with corn in order to secure a similar record for the whole field.

Permanent Improvements. The four teams with a force of seven men, in addition to other work, began early in June the construction of a roadway some 1,800 feet long from the farm house to the new highway which crosses the plain. Midway, in "Race Hollow," a small arch bridge was built of the rough stone available. The roadbed was constructed of stone taken from the fields and old walls. About one half acre of very rough, wet land immediately in front of the farm house was cleared of rocks, drained and seeded to grass, and more than an acre of the roughest portion of the farm between the farm buildings and the laboratory has been cleared sufficiently to admit of plowing and will be seeded to grass another year. These pieces of reclaimed pasture should produce very heavy hay crops. Very many stones were removed from the large field north of the orchards and from a portion of the land occcupied by the Horticultural division. About 300 feet of heavy bank wall was laid along the boundary of the new road just west of the bridge mentioned above.

Farm Crops. The last of the pasture land east of the college building was plowed late in the fall of '91. The past year about

half the land has been planted in corn and potatoes. The other half has been harrowed over at intervals to subdue the briars and weeds and get it into suitable condition for planting another year. From about one acre fertilized with sea-weed broadcast, 10 cords per acre, and 1200 pounds of fertilizer scattered in the drills and thoroughly worked in, 260 bushels of marketable potatoes of excellent quality were dug. The corn gave a good crop. The total yield, including experimental fields, was 840 baskets of ears. Of carrots 500 bushels were produced. Most of the oats were cut and cured green for fodder. The rye crop was fair and of good quality; 85 bushels were threshed but the grass sown with the rye gives little promise of a good stand. About four acres lying east of the Veterinary hospital have been seeded to grass and promises an abundant yield. Considerable June grass and orchard grass have been sown to produce a hay that will bear early cutting, and which will, upon moist land, throw up a second crop. So large an area of the plain land has been taken for experimental purposes that the acreage of grass this season was small, about 12 tons were cut. Of other fodders 8 tons of green oats and 2 tons of Hungarian were cured.

Farm Stock. In number there has been little change in the farm stock. The oxen were sold for beef about the first of January 1892 and two pairs of younger cattle purchased late in the spring when the work on the road began. One horse was purchased and one cow sold. The Jersey bull Experiment having become of little use as a stock getter was sold for beef. Two heifer calves (one pure Holstein) have been raised. The stock consists of 4 oxen, 5 horses, 3 cows, (1 Holstein, 1 Grade Guernsey, 1 native,) 1 Ayrshire bull, 1 Ayrshire heifer, 2 Holstein heifers, 1 grade Ayrshire heifer and 10 pigs.

School Garden. The labor of plowing, planting and care of the school garden was done by the students under the direction of the Director and his assistant during the spring term but from the middle of June to the middle of September the farm help did all

the cultivation. The same field, west of the college buildings was used with the exception that about one-half along the roadway was sown to oats and grass and the crop cut green and cured for fodder. About one and one-half acres was used for garden vegetables and small fruits of which a good supply was produced. Several bushels of strawberries were canned for winter use in the boarding house. Several hundred pounds of fine squashes were grown. A large quantity of promising muskmelons were partially spoiled by a mildew which spread rapidly over the vines just before the fruit ripened. It is a somewhat difficult task to arrange the products of the school garden to meet the requirements of the school year, the principal demand for garden products being *previous* to June 15th and *subsequent* to September 20th. Lettuce, asparagus, radishes, spinach and possibly a picking of peas are about all that can be produced in season for spring use and as frost comes soon after the fall term begins it is little use to plant many of the more tender and delicate of the garden vegetables.

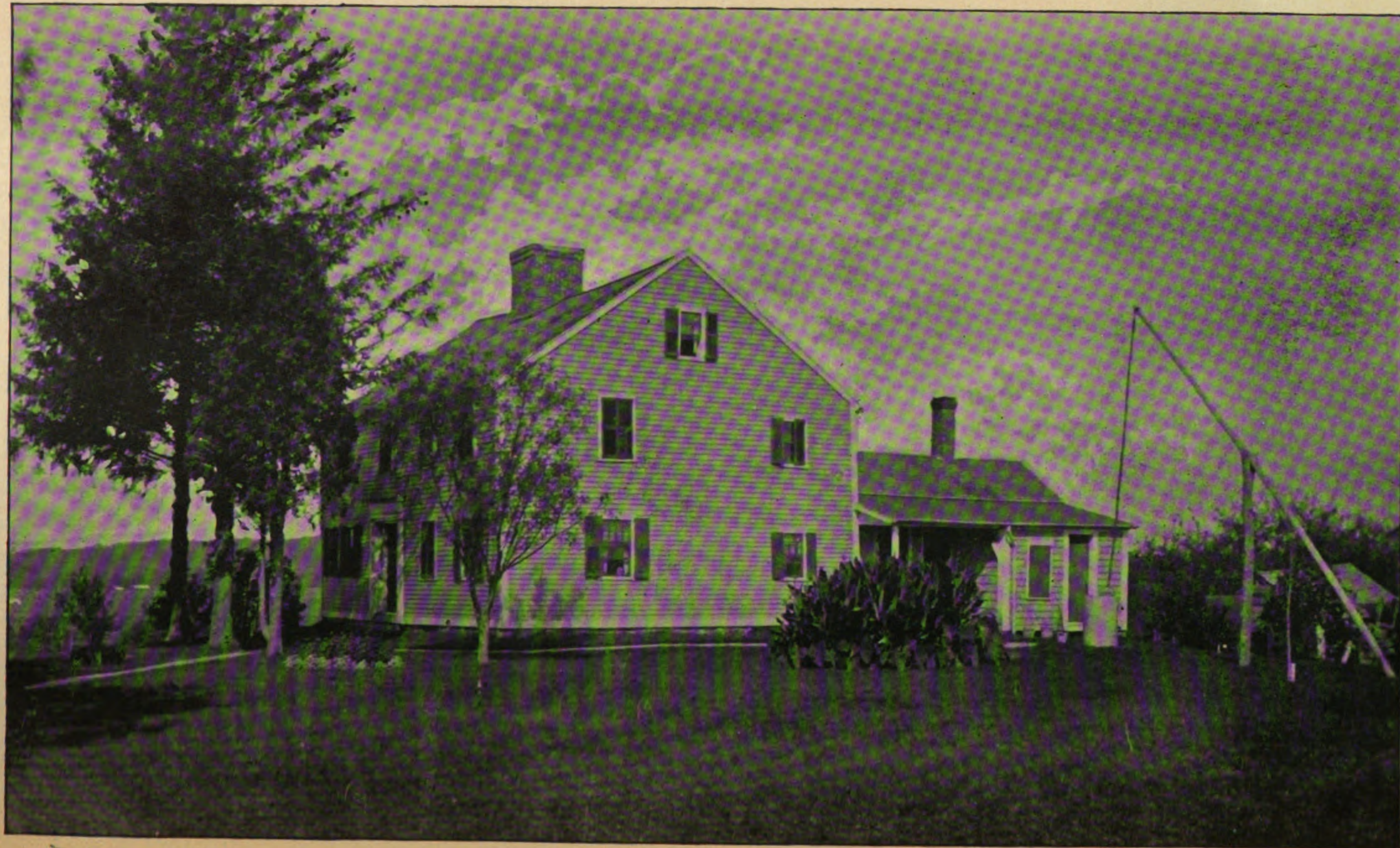
Visitors and Correspondents. The number of visitors to the Station and the inquiries received by the heads of the various divisions asking information upon numerous topics has largely increased over previous years. Whenever possible information is willingly supplied. Considerable advice relative to the use of special fertilizers for particular localities or special crops has been supplied by the chemist and the Director and the results thus far have been satisfactory in every way. Visitors are always welcome; we like to have the farmers of the State visit the Station and appreciate any suggestions and criticisms they may make.

World's Columbian Exposition. During the fall samples of soil were taken from eight different places within the State for exhibition in the soil alcove of the Experiment Station exhibit in the Agricultural building at Chicago in 1893. These soils illustrate the character and condition of the soil in a natural position to the depth of three feet. The samples will be accompanied with analyses of the surface, or agricultural soil. Collections of the

waste materials from our manufacturing industries, used, or of value as fertilizer are being made, and charts of a portion of our experimental work are being prepared for other portions of the same exhibit.

In closing, I wish to acknowledge the hearty coöperation of all the Station workers and the uniform spirit of energy and enterprise that has characterized the work of the year. I wish also to thank those who have conducted the coöperative field experiments for another year's care and labor, and finally to express my appreciation of the evident increasing interest on the part of the public in the work of the Station as manifested in many ways. It is ever the aim and purpose of the Experiment Station and its workers to serve the public in every possible legitimate manner.

CHAS. O. FLAGG,
Director.



View of Experiment Station Farm House, Summer 1892.

AGRICULTURAL DIVISION.

CHAS. O. FLAGG. J. D. TOWAR.

WINTER AND SPRING APPLICATION OF ASHES TO NEWLY SEEDED MEADOW.

Second Year. On page 22 of our last annual report is a full description of the land, condition of application and first year's yield of hay. Timothy and redtop were sown upon light sandy loam land, September, 1890. Two adjacent plots of one-fifth acre each were staked out. Upon the west plot, January 6, 1891, one-half ton of unleached Canada ashes was applied broadcast from a cart, the ground being frozen and covered with about three inches of snow at the time. A corresponding one-half ton was placed in barrels under cover until April 10th, when, the frost being out and the earth soft from the spring rains, the ashes were spread upon the east plot by hand, from baskets, at considerable more expense than was required in applying the ashes to the west plot. The yield of the two plots for the two years is as follows:

	1891	1892	Total.
W. plot, winter application, yield per acre	1906	1060	2966
E. plot, spring " "	1497	1040	2537
Difference in favor of winter application.......	409	20	429

The increase of the winter application over the spring application in the crop of 1892 was less than 2 per cent., while in 1891 it was 27 per cent., and the two years' total shows a gain of 16.9. The soil of these plots is in very poor condition as regards fertility and the yield of hay small. The ashes applied were not of a very high grade, as is shown by the analysis found in full upon page 145 of Bulletin No. 11, sample No. 20. They contained only 4.43 per cent. of potash and 1.37 of phosphoric acid, while an average hard wood ash should contain nearly or quite 6 per cent. of potash.

SHRINKAGE IN CURING TWO VARIETIES ON FIELD CORN.

On page 34 of the last annual report is found the comparative yield of white capped and Lackawaxen field corn, season of 1891. Each is a white flint, eight rowed variety. The ears of the white capped variety will measure from 7 to 9 inches in length, while those of the Lackawaxen are larger, measuring from 11 to 14 inches long. When this corn was husked, November 5, 1891, average sound ears of each were selected and 50 pounds of each placed in bags and hung in the corn crib during the winter. When thoroughly air dry, April 15, 1892, the corn was weighed, the loss by drying determined, and the proportion of shelled corn to cob also found.

	Weight Nov. 5, 1891.	Weight April 15, 1892.	Shrinkage.	Per cent. of shrinkage.	Shelled corn.	Cob.	Percentage of corn.	Percentage of cob.
	lbs.	lbs.	lbs.		lbs.	lbs.		
White Capped..........	50.	42.25	7.75	15.5	36.0	6.25	85.2	14.8
Lackawaxen...........	50.	38.00	12.00	24.0	30.5	7.50	80.2	19.8

According to these per cents. of shrinkage, it would require 77.7 pounds of ears of the white capped variety at time of harvest to make one bushel of well dried shelled corn, and of the Lackawaxen 91.9 pounds. We quote the following bearing on the same point: *

"The amount of ears at harvest required to make one bushel merchantable grain (11 per cent. water) varies from 79 to 90 pounds. From experiments covering three years it is found that the average weight of corn at harvest required for one bushel of dry shelled corn (11 per cent. water) is 84 pounds." From the above it will be seen that a greater number of pounds of ears at harvest is required for a bushel of merchantable corn than is usually supposed."

TEST OF VARIETIES OF OATS.

Of the twenty-eight varieties of oats grown last year, all the seed of the best ten varieties was sown this season, April 20, in sandy loam soil, well fertilized with barnyard manure. The results of this test are as follows:

Early Blossom. A clean, white, heavy kernel with the husk adhering closely to the berry. Ripens July 25. Straw of medium size, about 42 inches high and 2-3 lodged. Yield per acre—Grain, 109.4 bushels; straw, 7,288 pounds. Weight of grain per measured bushel, 42 lbs., 4 oz.

Russian. Good normal grain. Medium fine straw 40 inches high; none lodged. Ripens July 29. Yield per acre—Grain, 86.4 bushels; straw, 6,527 pounds. Weight of grain to the measured bushel, 36 lbs., 12 oz.

Vermont. Normal grain. Straw medium quality; height 40 inches. Slightly lodged. Ripe July 27. Yield per acre—Grain, 85 bushels; straw, 6,466 pounds. Weight of grain per measured bushel, 35 lbs., 12 oz.

Chennailles Black. A large, heavy, black oat with a fine, short

* Fifth Annual Report Storr's School Agricultural Experiment Station, page 86.

straw about 34 inches high, none of which was lodged. Ripe August 6th. Yield per acre—Grain, 83.3 bushels; straw, 7,544 pounds. Weight of grain per measured bushel, 36 lbs., 10 oz.

Bavarian. A very common appearing grain on medium straw of 48 inches height; none lodged. Ripe August 8. Yield per acre—Grain, 79.3 bushels; straw, 7,472 pounds. Weight per measured bushel, 36 lbs.

Michigan Clipped. Medium quality of oats with tall, coarse straw, about 45 inches high and 3-4 lodged. Ripe August 3d. Yield per acre—Grain, 78.9 bushels; straw, 5,900 pounds. Weight of grain per measured bushel, 34 lbs.

Rosedale. A handsome, plump, heavy oat. Grain of much the same appearance as the Early Blossom. A side oat (i. e. the grain grows on one side of the stalk.) The grain shelled badly in handling. Straw medium coarse about 40 inches high and nearly all lodged. Yield per acre—Grain, 76.2 bushels; straw, 7,090 pounds. Weight of grain per measured bushel, 39 lbs., 4 oz.

New York State. Medium quality of oats; fine stiff straw 36 inches high and none lodged. Ripened August 2d. Yield per acre—Grain, 76.2 bushels; straw, 5,602 pounds. Weight of measured grain per bushel, 36 lbs.

Joanette Black. This variety is very similar to the Chennailles Black. Ripened August 6. Yield per acre—Grain, 74.4 bushels; straw, 6,239 pounds. Weight of grain per measured bushel, 35 lbs., 4 oz.

Improved American. It may be said of this, the Russian, Vermont, Michigan Clipped, Bavarian and New York State, that in appearance they are very much alike both when growing and in the grain bin. The straw of the Improved American is about 40 inches high, medium quality and texture, none lodged. Ripens July 29. Yield per acre—Grain, 74.4 bushels; straw, 6,012 pounds. Weight of grain per measured bushel, 37 lbs., 12 oz.

All of the seed of these varieties was given the Jensen hot water treatment for the destruction of smut. The treatment

proved very effectual, as we were unable to find a single stalk of smutted oats during the period of growth or at the time of harvest. We shall continue the growth of these ten varieties during the coming season.

THE JENSEN HOT WATER TREATMENT OF OATS FOR THE PREVENTION OF SMUT.

(Loose smut of oats *Ustilago avenæ* (Pers.) Jensen.)

The almost universal presence of the spores of this fungus upon the oats used for seed and the damage resulting from its subsequent growth in the crop has been pointed out.* The success at other Stations in the use of the Jensen hot water treatment of the seed as a remedy for the disease has been more pronounced than the results at this Station the past season. All the oats sown last spring, with the exception of seed for small "control plots," were subjected to the hot water treatment and the crops resulting were very satisfactory both in yield and entire absence of smut, but as the yield of the untreated oats on the control plots was equally good, with almost no smut, (less than 1 per cent.) further experiment is necessary in order to get conclusive results. The method of treatment is given in full in Bulletin No. 15. It is but little trouble to treat seed enough for a large field. Have a wash tub and fill two-thirds full of water at a temperature of 135°. Have also a convenient supply of water kept boiling hot. Put half a bushel of oats into a bushel basket and immerse in the tub. Shake the basket so that all the oats shall be wet. As the water is cooled by the basket of oats add enough boiling water to bring the temperature up to 135.° Stir the oats with a stick and lift the basket out of the water occasionally for a moment to drain out the cool water and admit the hot water to the middle of the basket when again immersed. *Keep the oats immersed ten minutes* after the temperature has *ceased to fall below* 130° and at the same time it should not exceed 135°, as a higher temperature than that

* Bulletin No. 15.

is likely to injure the vitality of the seeds. At the end of the ten minutes drain out the water, spread on a floor and stir occasionally until dry. All bags, boxes or measures used for handling the oats after treatment should *first* be thoroughly treated with boiling water to kill all spores of smut. The oats will not be injured by keeping several weeks before sowing if carefully dried.

The following table gives the results of the test, including a full set of duplicate plots:

Table showing the temperature of the water, the number of minutes the seed was immersed, percentage of lodged grain, number of smutted heads to the acre and the yield in pounds of grain and straw per acre.

No. of plot.	Temperature of the water.	Time immersed.	Percentage of lodged grain.	Number of smutted heads to the acre.	Yield of grain per acre.	Yield of straw per acre.
1	125°	10 minutes..	90 per cent..	None.....	2084 pounds.	8578 pounds.
2	127½°.	10 " ..	90 " ..	None....	2183 "	8252 "
3	130°	10 " ..	35 " ..	None. ..	2070 "	7912 "
4	Untreated. ..	....	50 " ..	15,427....	2467 "	7969 "
5	132½°.	10 minutes..	35 " ..	None. ..	2311 "	7671 "
6	135°	10 " ..	15 " ..	None.....	2382 "	8281 "
7	137½°.	10 " ..	40 " ..	None. ..	2183 "	7345 "
8	Untreated. ..	....	60 " ..	6,367......	2325 "	7090 "
9	140°	10 minutes..	20 " ..	None. ..	2297 "	8366 "
10	142½°.	10 " ..	5 " ..	None....	1701 "	7260 "
11	145° .	10 " ..	0 " ..	None. ..	1262 "	5317 "
12	Untreated. ..	....	90 " ..	10,890. ...	2779 "	8224 "

DUPLICATE PLOTS.

13	125°........	10 minutes..	50 per cent.	None.....	2325 pounds.	8224 pounds.
14	127½°	10 " ..	50 " ..	None. .	2084 "	7246 "
15	130°........	10 " ..	50 " ..	None.....	2736 "	7699 "
16	Untreated. ..	....	10 " ..	11,797 ...	2042 "	6182 "
17	132½°.	10 minutes..	10 " ..	None. ..	2155 "	6125 "
18	135°	10 " ..	40 " ..	None. ..	2368 "	6367 "
19	137½°.	5 " ..	0 " ..	None.....	1843 "	5984 "
20	Untreated. .	....	20 " ..	18,150....	2382 "	6579 "
21	140°.... ...	5 minutes..	5 " ..	None....	2495 "	6806 "
22	142½°.	5 " ..	0 " ..	None. ..	1801 "	5005 "
23	145°.... ..	5 " ..	0 " ..	None.....	1049 "	3602 "
24	Untreated. ..	....	20 " ..	13,612....	2495 "	6352 "

AVERAGE YIELDS.

	Yield of grain per acre.	Yield of straw per acre.	Smutted heads per acre.
Untreated	2415 pounds...	7066 pounds...	12,707
Treatment at 130°-135°	2337 " ...	7342 " ...	None.
Treatment at 137½° and higher	1829 " ...	6211 " ...	None.

The plots upon which this experiment was conducted were laid out in three parallel rows of eight plots each; plots, 3, 6, 9, 12, 15, 18, 21 and 24 were in the outside row, which was next to the edge of sward, and the increased yield in all these plots indicates a higher condition of fertility than existed in the soil of the other two rows of plots.

Although no smutted stalks were found on any of the plots where the seed was treated, it seems from the results of this experiment that a temperature ranging from 130° to 135° F. with ten minutes time is best suited to this treatment.

From observations made in two other oat fields in this neighborhood it was found that the quantity of smut present was very small in this locality. This fact may account for the undiminished yield of the untreated plots, which have given a better average yield of grain than the treated plots, though in straw their yield is somewhat less.

Where the seed was submitted to a temperature above 135° (except plots 9 and 21 in the outside row where the treatment was 142°) the yields decrease as the temperature is raised.

As to the vitality of the seed treated at the various temperatures, there was no apparent difference where the treatment was below 137½°. Above that temperature it was evident that the vitality of a portion was destroyed as the temperature was raised. The seed was sown April 20, and on May 13, when the green blades were 2½ inches high, about ¾ of the seed sown on plots 9 and 21 had germinated, ½ on 10 and 22 and 1-20 on 11 and 23.

The reason why these plots yielded grain in quantity greater than the relative amount of seed that germinated is undoubtedly due to the fact that where only a small quantity of seed grew, it had more room and made a more vigorous and productive growth.

From the above experiment we may conclude:

1. That the most desirable temperature to which the seed should be submitted is 130°–135° F. for a period of ten minutes.

2. That above 137½° the vitality of the seed is seriously impaired.

3. While smut was found on every untreated plot and in fields in the neighborhood where the seed was not treated, no trace of smut was found on grain where the seed was given treatment at temperatures varying from 125°–145,° nor in our field oats where the seed was treated in the ordinary way, ten minutes at 135,° although careful search was made.

FERTILIZER EXPERIMENT WITH OATS.

In our Third Annual Report, 1890, page 17, is a table showing the yield of oats from nine ¼ acre plots, 4 of which received Earl's Horsefoot guano, 3 mixed chemicals and 2 nothing. In 1891 the entire field was spread with seaweed to the amount of 9 1-7 cords to the acre, and the Fourth Annual Report, page 25, gives the result of that year's experiment. In the spring of 1892 the plots were divided in halves and one half given a broadcast dressing of air slacked lime, 1776 pounds to the acre, the other half received nothing. These halves were again divided in the middle and the experiment of drilling and broadcasting continued.

The table is a brief record of the yield for 1890 and 1891 and a complete record of the past year's experiment.

Table showing results of three years' experiment with fertilizers on oats.

	1890. Fertilizer Applied.	1890. Average yield per acre. Grain.	1890. Average yield per acre. Straw.	1891. Fertilizer applied.	1891. Average yield per acre. Grain.	1891. Average yield per acre. Straw.	1892. Plot number.	1892. Fertilizer Applied.	1892. How Sown.	1892. Yield per acre. Pounds of grain.		1892. Yield per acre. Pounds of straw.		1892. Average Yields. Pounds of grain.		1892. Average Yields. Pounds of straw.		Average yields of original plots.	
		lbs.	lbs.		lbs.	lbs.													
A..	Earl's Horsefoot Guano,			9.14 cords of seaweed, costing $4 per cord = $36.56 per acre.			1a.	1776 lbs. Lime	B.*	364		1051							
	at a cost of $14.02 per acre...	420	1514		1840	3252	2a.	per acre.	D.		532		1321	448		1186		408	981
							3a.	Nothing.	D.		313		776						
							4a.		B.	422		776			367		776		
B..	Nothing...						1b.	1776 lbs. Lime	B.	525		1001							
		78	360		1827	3235	2b.	per acre.	D.		483		1477	504		1239		468	1152
							3b.	Nothing.	D.		378		1147						
							4b.		B.	486		984			432		1065		
C..	‖ Mixed Chemicals,						1c.	1776 lbs. Lime	B.	507		1181							
	at a cost of $14.02 per acre...	560	1492		1560	2395	2c.	per acre.	D.		606		1491	556		1336		496	1219
							3c.	Nothing.	D.		402		1150						
							4c.		B.	471		1053			436		1101		
	Averages...				1742	2961				462	452	1008	1227	503	412	1254	981	457	1117

* D.—Drilled. B—Broadcast.

‖ Mixed chemicals contained 74 lbs. muriate of potash, 100 lbs. nitrate of soda, 403 lbs. of dissolved bone, 100 lbs. fine ground bone, 100 lbs. tankage and 100 lbs. sulphate of ammonia.

In the study of this work there are four points to notice. 1st, the lasting effect, if any, of the application of guano and chemicals in 1890. 2d, the effect in 1892 of the application of seaweed for the crop of 1891. 3d, the effect of lime upon the crop. 4th, the difference between broadcasting and drilling the seed.

The beneficial effect of the materials applied in 1890, as seen in the last column of the table, appears to have vanished entirely, as the yield of the nothing plot exceeds the Horsefoot guano plot by 15.7 per cent., and is only 6 per cent. below the yield of the mixed chemical plot. Two years out of three, equal value of mixed chemicals gave a better crop than Horsefoot guano.

As a result of the application of seaweed in 1891 we had a fair crop of oats that year, the average yield being about 54½ bushels of grain and 2961 pounds of straw. But the comparative small yield of the field in 1892, especially where no lime was used, leads us to conclude that the strength of the seaweed was almost entirely eliminated by the crop in 1891.

From the averages given at the bottom of the table it will be seen that the lime increased the yield per acre of grain 91 pounds, or 22 per cent., and of straw 273 pounds, or about 28 per cent. It may also be added that the clover sown on the limed portion made a much more vigorous growth. Some notes on the growth and yield of the clover crop may be taken this season.

As to the method of sowing, the yield of grain where the seed was sown broadcast is 2.2 more than where drilled, while the drilled seed produced about 12 per cent. the more straw.

YIELD OF CORN WITHOUT FERTILIZERS ON PERMANENT PLOTS.

In 1891 the portion of the plain devoted to permanent plots, as described and illustrated by diagrams on pages 13–16 of the Fourth Annual Report, was planted to beans. The yields of this crop were not considered of sufficient value to remain as the only record of the condition of this soil and it was, therefore, decided to plant the plots to corn for one year before beginning any ex-

tended experiments on them. The variety of corn planted was white-capped flint corn. To the 40 plots shown in the diagram, 8 more have been added and preparations are being made to increase the number to about ninety. It is apparent, from the table given below, that plots 1-16 and 43-48 have in the past received more manure than the remaining plots. This, of course, will be an obstacle in the way of making comparison between these plots of different degrees of fertility.

It will also be noticed in the tables that plots 17-42 inclusive give no yields of hard corn, soft corn and stover. This is due to the fact that the products of these plots was a sickly growth, of short immature stalks, bearing no ears whatever. For a general comparison of all the plots we can, therefore, use the first column of numbers only which gives the yield of green unhusked crop on September 22, the day it was cut.

The following table shows :

The yield of the corn crop from the forty-eight 1-10 acre permanent plots.

No. of Plot.	Yield of Green Material.	Hard Corn on the Cob.	Soft Corn on the Cob.	Dry Stover after husking.
1.	560 Pounds.	119 Pounds.	42 Pounds.	113 Pounds.
2.	395 "	41½ "	67 "	82 "
3.	490 "	105 "	32½ "	80 "
4.	375 "	34 "	45 "	75 "
5.	365 "	28 "	70½ "	70 "
6.	475 "	43 "	101½ "	108 "
7.	430 "	48¼ "	77 "	90 "
8.	395 "	44½ "	67 "	85 "
9.	455 "	60¼ "	72 "	90 "
10.	425 "	46¾ "	71 "	85 "
11.	605 "	95¼ "	97 "	113 "
12.	365 "	36¼ "	70½ "	75 "
13.	635 "	140 "	63 "	91 "
14.	485 "	67 "	94 "	90 "
15.	250 "	23 "	40¼ "	55 "
16.	410 "	71½ "	51 "	85 "
17.	38 "	....	....	....
18.	27 "	....	....	....
19.	20 "	....	....	....
20.	39½ "	....	....	....
21.	19 "	....	....	....
22.	64 "	....	....	....
23.	7 "	....	....	....
24.	150 "	....	....	....
25.	44 "	....	....	....
26.	265 "	....	....	....
27.	36 "	....	....	....
28.	140 "	....	....	....
29.	28 "	....	....	....
30.	90 "	....	....	....
31.	47 "	....	....	....
32.	67 "	....	....	....
33.	87½ "	....	....	....
34.	140 "	....	....	....
35.	30 "	....	....	....
36.	38 "	....	....	....
37.	62 "	....	....	....
38.	43 "	....	....	....
39.	55 "	....	....	....
40.	45 "	....	....	....
41.	87½ "	....	....	....
42.	75 "	....	....	....
43.	917 "	247½ Pounds.	80½ Pounds.	217 Pounds.
44.	480 "	95 "	26½ "	128½ "
45.	885 "	230½ "	29 "	180 "
46.	885 "	221 "	34½ "	184½ "
47.	860 "	276½ "	44½ "	219 "
48.	845 "	224 "	38½ "	177½ "

TRIALS OF DIFFERENT FORMS OF PHOSPHATES.

With Double Superphosphate from The American Chemical and Phosphate Company, Baltimore, Md., and Dissolved South Carolina Bone, Dissolved Boneblack, Slag Meal and Floats from W. S. Powell & Co., Baltimore, Md., a comparative trial was made of their value on the Indian corn crop. This experiment was tried on two different portions of the farm, one on the plain, on sandy loam soil which the previous year was treated to a mixture of ground bone (675 lbs.) muriate of potash (246 lbs.,) and nitrate of soda (184 lbs.) and yielded about 21 bushels of hard corn and 1 ton of stover per acre; and one on the hill on heavy loam, somewhat wet, with clay subsoil. This land had been in grass for several years and yielded less than 1-2 ton of hay per acre. The corn on the hill was planted with hand corn planters June 2d, in hills three feet apart each way and was cut September 23d. That on the plain was planted in the same manner on June 8, and cut September 29; thus making the period of growth precisely the same in both cases.

It was first determined that it took 770 lbs. of Dissolved S. C. Rock to make 100 lbs. of phosphoric acid, ($P_2 O_5$). The cost including freight of 770 lbs. of Dissolved S. C. Rock, $6.35, was taken as a basis and an equal money value of each material used in the comparison. The experiment was extended to a plot (No. 3) which received 100 lbs. of phosphoric acid in the form of dissolved boneblack requiring 670 lbs. at a cost of $8.33 per acre; thus making six 1-10 acre plots in each experiment.

Tabulated below are the names, amounts and cost of materials used together with the results of the experiment.

Table showing kinds, quantity and cost of fertilizers.

No. of Plot.	Name of Fertilizer.	Per cent. of Phosphoric Acid.	Pounds of Phosphoric Acid applied per acre.	Pounds of Phosphate used per acre.	Cost of Phosphate.	Pounds of Nitrate of Soda used per acre.	Pounds of Muriate of Potash used per acre.
1	Dissolved S. C. Bone	13	100	770	$6 35	320	200
2	Dissolved Boneblack	15	76.2	508	6 35	320	200
3	Dissolved Boneblack	15	100	666	8 33	320	200
4	Double Superphosphate	40	116	290	6 35	320	200
5	Floats	26	222	836	6 35	320	200
6	Slag	19	115	605	6 35	320	200

Table showing amount and money value of yield.

	No. of Plot.	Yield per acre.			Value of Crop per Acre.			
		Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled corn.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled corn).	Stover.	Hard Corn, 75 cents per bushel.	Soft Corn, 37½ cents per bushel.	Stover, $7.00 per ton.	Total Value of Crop.
		Bush.	Bush.	Tons.				
Experiment on the Plain.	1...	62.28	1.71	2.835	$46 71	$ 64	$19 84	$67 19
	2...	58.00	4.00	2.68	43 50	1 50	18 76	63 76
	3...	64.53	.78	2.7635	48 40	29	19 34	68 03
	4...	55.78	2.93	2.245	41 83	1 09	15 71	58 63
	5...	56.14	3.00	2.28	42 10	1 12	15 96	59 18
	6...	63.35	4.35	2.555	47 51	1 63	17 88	67 02
Experiment on the Hill.	1...	42.07	1.60	1.196	31 55	60	8 37	40 52
	2...	37.28	1.85	1.08	27 96	69	7 56	36 21
	3...	41.21	1.71	1.0725	30 91	64	7 51	39 06
	4...	39.21	1.28	1.1825	29 41	48	8 27	38 16
	5. .	33.10	2.14	1.0425	24 82	80	7 29	32 91
	6...	37.85	1.42	1.05	28 39	53	7 35	36 27

TRIAL OF VARIETIES OF MUSK MELONS.

From a prominent seed store we procured one packet each of the following varieties of musk melons and planted them in the school garden: Hackensack, Extra Early Hackensack, Emerald Gem, Prize Jenny Lind, Montreal, Winter Pineapple, Banana, Hardy Ridge, Bay View, Osage, Early Improved Christiana, Casaba, Baltimore, Columbus, Perfection, Netted Gem and Starn's Favorite. The seed was planted in rich garden soil on May 18 and with the exception of Hardy Ridge, the varieties all made a good growth and gave promise of a fair crop of melons. As soon as the first melons began to ripen a blight or mildew appeared upon the vines and spread quite rapidly until it had affected all of the late varieties. The Bordeaux Mixture was applied as an experiment upon the vines and fruit of a portion of the field, with the hope of saving the crop, but to no avail, while the blue discoloration left upon the melons gave them a very undesirable appearance. Melons of nearly all the varieties reached maturity and 3 good specimens of each were exhibited at the Kingston Fair.

Below we give tabled notes of each variety in the order of general desirability. Those ripening late were, of course, affected seriously by the loss of foliage, both in size and quality and some that were very inferior under the circumstances would undoubtedly be desirable when thoroughly developed and fully ripe.

Name of Variety.	Date of ripening	Size.	Quality.	Remarks.
Emerald Gem	Aug. 30.	Small.	Excellent..	All ripened before the blight.
Baltimore.........	Aug. 30	Small.	Good.....	Tendency to rot.
Jenny Lind......	Sept. 1.	Medium......	Fair	Very productive.
Bay View.	Sept. 1.	Large medium	Fair......	Very productive.
Hackensack, two kinds...........	Sept. 1.	Large	Poor	Coarse and tasteless.
Casaba....	Sept. 1.	Large.......	Fair......	Much like Jenny Lind.
Starn's Favorite...	Sept. 10.	Medium......	Excellent.	Very desirable, though late.
Netted Gem.......	Sept. 5.	Small.........	Good.....	A fine, small melon.
Early Improved Christiana	Sept. 5.	Medium.... .	Fair......	Rotted badly.
Perfection.........	Sept. 15.	Medium......	Very good	A very solid melon, quite unproductive.
Columbus	Sept. 15.	Large medium	Poor.	Unproductive.
Osage	Sept. 20.	Medium	Fair......	Rotted badly.
Banana.....	Sept. 20	Long..... ..	Poor	Tasteless and undesirable.
Montreal.	... .	Very large ..	....	Did not mature.
Winter Pineapple..	....	Very large....	....	Did not mature.
Hardy Ridge.. ..	....	Large	....	Did not mature.

INDIAN CORN WITH LIME AND PHOSPHATES FOLLOWING BARNYARD MANURE.

On a plot of ground which in 1891 received a liberal dressing of barnyard manure, a trial was made with the following three forms of phosphates, Dissolved South Carolina Bone, Dissolved Boneblack and Double Superphosphate. It was also sought to determine the effect of air-slacked lime with each form of phosphate and alone upon the soil not treated with phosphate. This

necessitated using four plots for each phosphate tested, one receiving lime only, one nothing, one the phosphate alone, and one both lime and phosphate. The table of this experiment gives the quantity of fertilizer applied and the result of the two year's experiment in full.

Table showing the effect of various Phosphates, with and without Lime, on the Indian Corn crop on soil treated the previous year with barnyard manure.

Without Lime.					1892.					
	1891.				Fertilizer Applied.		Yield per Acre.			
No. of Plot.	Fertilizer applied.	Yield per acre, total value of which is $70.94.			Kind.	Lbs. per Acre.	Hard Corn. bush.	Soft Corn. bush.	Stover. lbs.	Total Value per Acre.
1	12 cords Stable Manure valued at $78.50 per Acre.	74.66 bushels Hard Corn valued at $56.00 per Acre.	2.31 bushels Soft Corn valued at $ .87 per Acre.	4020 pounds Stover valued at $14.07 per Acre.	Air Slacked Lime..	1400	40.68	4.67	2350	$40 48
2					Nothing.	....	43.10	2.42	2167	40 76
3					{ Air Slacked Lime.......	1400	....	......	..	......
					{ Dissolved Boneblack. ...	800	59.86	2 55	3196	57 02
4					Dissolved Boneblack.......	800	58.28	2.42	3060	55 33
5					Air Slacked Lime..:.... ..	1400	48.45	1.09	2822	46 63
6					Nothing.....	....	52.21	2.30	2898	50 16
7					{ Air Slacked Lime.	1400	......	......		......
					{ Dissolved S. C. Bone.....	880	53.79	2.91	3330	53 09
8					Dissolved S. C. Bone.......	880	55.13	1 09	3204	52 97
9					Air Slacked Lime..........	1400	55.61	1.58	3047	52 96
10					Nothing.	..	50.51	1.09	3017	48 84
11					{ Air Slacked Lime........	1400	.....	......	.	.....
					{ Double Superphosphate .	320	60.47	97	3179	56 84
12					Double Superphosphate ...	320	56.70	1.58	3060	53 82

Taking the average of the total values of the three nothing plots (2, 6 and 10 = $46.46) and of the three plots which received lime only (1, 5 and 9 = $46.69) we have as a result of the addition of lime a gain of only 23 cents per acre.

The increase of yield over the average of the nothing plots as a result of the addition of the phosphates is for the dissolved boneblack $8.87; for the dissolved S. C. Bone, $6.51, and for the double superphosphate, $7.36.

As a result of applying lime with the various phosphates, to dissolved boneblack it increased the yield $1.69; to dissolved S. C. bone, 12 cents, and to double superphosphate, $3.02.

Though the lime has shown no decided benefit in the above experiments, its action upon the oats and clover to follow will be watched with much interest.

FERTILIZER EXPERIMENT WITH CORN, SECOND YEAR.

The experiment described in our annual report of 1891, pages 31-34, was continued the past season, using air-slacked lime and double superphosphate, as will be seen in the following table:

Table showing results of two years' experiments with Fertilizers on Indian Corn.

No. of Plat.	1891. Fertilizer applied per Acre. KIND.	Quantity.	Cost.	Total Yield per Acre. Hard Corn.	Soft Corn.	Stover.	Total Value.	1892. Fertilizers Applied per Acre. KIND.	Quantity.	Total Yield per Acre. Hard Corn.	Soft Corn.	Stover.	Value.
	GROUP A.			bush.	bush.	lbs.			lbs.	bush.	bush.	lbs.	
1								Lime	1400	55.61	1.58	3047	$52 96
2								Nothing		50.51	1.09	3017	48 84
3	Barnyard Manure	12 cds.	$78 50	74 66	2.31	4020	$70 94	Lime	1400				
								Double Superphosphate	320	60 47	.97	3179	56 84
4								Double Superphosphate	320	56.70	1.58	3060	53 82
	GROUP B.	lbs.											
5	Dissolved Boneblack	437						Lime	1400	44 01	1.75	2322	41 79
6	Nitrate of Soda	375	19 63	35.43	6.21	2346	37 11	Nothing		46.99	1.45	2132	43 25
7	Muriate of Potash	163						Lime	1400				
								Double Superphosphate	320	51.42	1.09	2359	47 23
8								Double Superphosphate	320	52.76	1.03	2864	49 97
	GROUP C.												
9	Dissolved Boneblack	875						Lime	1400	49.66	1.09	2652	46 93
10	Nitrate of Soda	750	39 25	31.54	6.91	2421	34 72	Nothing		46.02	1.21	2813	44 80
11	Muriate of Potash	325						Lime	1400				
								Double Superphosphate	320	51.54	2.06	2877	49 49
12								Double Superphosphate	320	48.68	2.42	2966	47 80
	GROUP D.												
13	Dissolved Boneblack	1750						Lime	1400	62.17	2.79	2507	56 45
14	Nitrate of Soda	1500	78 50	28.06	9.6	2728	34 20	Nothing		60.47	2.63	1693	52 26
15	Muriate of Potash	650						Lime	1400				
								Double Superphosphate	320	65.06	3.21	3719	63 03
16								Double Superphosphate	320	57.68	2.79	3217	55 67
	GROUP E.												
17								Lime	1400	61.14	1.82	4008	60 55
18								Nothing		58.28	2.55	4156	59 21
19	Commercial Fertilizer	4572	78 50	61.30	3.88	4812	64 29	Lime	1400				
								Double Superphosphate	320	67.27	2.30	4649	67 58
20								Double Superphosphate	320	62.65	.50	3910	60 86

Comparing the yields of the nothing plots this year with the yields of last year it is found that with no addition of fertilizer the second year, the yield has increased in every case except where commercial fertilizer was applied. This is doubtless due to the more thorough decomposition of the sod and the better physical condition of the soil this year than last.

It is interesting to note the product of the nothing plots with a view of determining the lasting effects of the materials applied the previous year. Plots 2, 14 and 18 received in 1891 the same money value respectively of barnyard manure, mixed chemicals and commercial fertilizer, and nothing to either in 1892. The yield of hard corn per acre was as follows in bushels: No. 2, 50.51; No. 14, 60.47; No. 18, 58.28, the greatest yield being upon the mixed minerals, plot No. 14, group D, 2.19 bushels more than produced by the commercial fertilizer and 9.96 bushels more than from the barnyard manure. Comparing the soft corn and the stover we find in regard to the latter a difference in favor of the commercial fertilizer, the weights of stover being in the order named. No. 18, 4156 pounds; No. 2, 3017 pounds, and No. 14, 1693 pounds. In attaching a money value to the total crop the larger yield of stover on the nothing plot in group E gives the crop grown on the commercial fertilizer the greatest value, $59.21; that upon mixed chemicals second, $52.26, and barnyard manure third, $48.84. The small yield of stover on plot 14 was undoubtedly due to the fact that the nitrogen was wholly in the form of nitrate of soda. One half the large amount of nitrogen in the form of dried blood or tankage would probably have given a larger crop —certainly more stover—and been more economical in so heavy an application.

Comparing in each group the plot receiving lime with the nothing plot, we find a gain in the yield of hard corn in all but one group—varying from 1.70 bushels in group D to 5.10 bushels in group A. The loss in group B was 2.98 bushels.

Comparing in each group the plot receiving double superphos-

phate with the nothing plots, we find that all but one have made a gain varying from 2.66 bushels in group C to 6.19 bushels in group A. In group D there was a loss of 3.78 bushels.

The addition of lime and double superphosphate together gave an increase in every instance of from 4.43 bushels hard corn in group D to 9.96 bushels in group A. The following table gives the cost of the lime and superphosphate and the increase over the nothing plots in total money value of the crop on the plots to which they were applied.

Table showing increase of crop per acre in money value from the application of lime and double superphosphate. The minus sign indicates a loss.

	Cost of manure, fertilizer or chemicals, 1891.	Value of crop of nothing plots.	Cost of lime, 1892.	Increase from the use of lime.	Cost of double superphosphate, 1892.	Increase from use of superphosphate	Cost of lime and superphosphate, 1892.	Increase from use of lime and superphosphate, 1892.
Group A........	$78 50	$48 84	$4 77	$4 12	$6 56	$4 98	$11 33	$8 00
" B........	19 63	43 25	"	—1 46	"	6 72	"	3 98
" C...... ..	39 25	44 80	"	2 13	"	3 00	"	4 69
" D....	78 50	52 26	"	4 19	"	3 41	"	10 77
" E.......	78 50	59 21	"	1 34	"	1 68	"	8 37

It will be seen that in only one instance was the application of either the lime or superphosphate, alone or together, profitable for this year's crop. The superphosphate in group B gave an increase in money value of $6.72 over the nothing plot at an expense of $6.56, or a gain of 16 cents. The effect upon future crops of the application of lime and superphosphate will be noted with interest.

FORAGE PLANTS.

A piece of strong loam land west of the Laboratory was set apart for testing varieties of forage and other new plants.

From Dr. O. C. Wiggin of Keysville, Va., was received a small package of Soja beans and two varieties of cowpeas. Another sample of cowpeas was taken from a lot of four bushels purchased from Jesse Jones & Son, of No. 16 Roanoke Dock, Norfolk, Va., and six varieties of Japanese beans were received from the Kansas Experiment Station.

Soja or Soya Bean. (Soja hispida, natural order Leguminosæ.) "This is a climbing annual plant allied to (*Dolichos*) ("cowpea"). It is much cultivated in tropical Asia on account of its beans, which are used for preparing a well-known brown and slightly salt sauce (Soy) used both in Asia and Europe for flavoring certain dishes, especially beef, and supposed to favor digestion."*

These beans were greenish yellow in color, spherical or slightly oval in shape and about one-fourth of an inch in diameter.

They were planted in drills two feet apart and about three inches apart in the drill, the 8th of June. The growth was rapid and dense, the plants being too thick for perfect development, but the stems are sufficiently woody to prevent lodging and a large quantity of green fodder was produced. The average height August 9th was 24 inches, which increased to 40 or 42 inches when the crop was cut, September 27th, and fed to the neat stock. It was eaten with evident relish. September 27th, the plants, 95 in number, upon 20 feet of drill were cut and weighed green 25.5 pounds, or at the rate of 27,769.5 pounds of green crop per acre. We believe this plant worthy of trial by those who desire a variety of crops for soiling and especially as, in common with all the *Leguminous* plants, it is rich in the nitrogenous elements. It could be easily cut and stored as ensilage but would be difficult to air dry and preserve in our climate, as the stems are somewhat thick and the leaves would drop off in curing. The plants grown here blossomed and seed pods formed but contained only the embryo of seeds at time of cutting.

* Henderson's Hand-book of Plants, page 417.

During the early winter a variety of this bean was extensively advertised by a party in Missouri as "Cole's Domestic Coffee Berry," and offered for sale at the extravagant price of $3.50 per pound. Its wonderful merit as a substitute for coffee was set forth in a "dodger" with "testimonials" attached. The seed can be purchased of J. M. Thorburn & Co., No. 15 John St., New York, or other large seed dealers, in small quantities, at fifteen cents (15 cts.) per pound.

The following table gives an average of three analyses of soja beans, two grown at the Massachusetts Experiment Station in 1889[1] and cut August 20th and August 30th, the third grown at the South Carolina Experiment Station[2] and cut in full bloom August 5th, 1889; and for comparison an average of five analyses of red clover cut in full bloom.[3]

Moisture in fresh material, 74.12 per cent. in soja bean and 72.70 in red clover.

Analysis of Dry Matter.	Soja Bean.		Red Clover.		Cowpea.	
	Per cent.	Pounds per ton.	Per cent.	Pounds per ton.	Per cent.	Pounds per ton.
Crude Ash	7.40	148.00	8.10	162	8.50	170
Protein	15.96	319.20	15 70	314	18.60	372
Fibre	23 63	472.60	23.80	476	22.50	450
Nitrogen free extract	47 93	958.60	49.20	984	47.20	944
Fat	5.08	101.60	3 20	64	3.20	64
	100.00	2000.00	100.00	2000	100.00	2000

1 Massachusetts State Experiment Station report, 1889, pages 144-146.

2 S. C. Agricultural Experiment Station Bulletin, No. 8, page 78.

3 Compilation American Feeding Stuffs, U. S. Department Agriculture, page 41.

As will be seen by the table the soja bean is superior to red clover in two most important particulars, protein and fat, especially the latter. As every stock owner is well aware of the practical feeding value of clover further comment as to the value of the soja bean is unnecessary.

In regard to the fertilizing value, the crop as grown this year gave a total weight of 27,769.5 pounds, 74.12 per cent. water, or 7,186.6 pounds of *dry matter*, containing as determined by our chemist 152.7 pounds of nitrogen.

The average of the same three analyses already referred to give the following fertilizer constituents of the soja bean plant cut in bloom:

Moisture.	Nitrogen.	Potash K_2O.	Phosphoric acid P_2O_5.
7.05 per cent.	2.37 per cent.	1.315 per cent.	.58 per cent.

Reducing the above to a dry basis we find that at the same rate the above crop would contain 101.6 pounds of actual potash (K_2O) and 44.84 pounds of phosphoric acid (P_2O_5). Calculating these at the prices adopted this year as the basis of calculating fertilizer values in feeding stuffs we have the following:

Crop from one acre of soja beans cut and weighed green, 27,769.5 pounds, = ... { Water..... 20,582.9 pounds. / Dry Matter 7,186.6 pounds.

Dry Matter, =	Nitrogen	152.7 lbs.	× 16½ cents	=	$26.72
	Potash (K_2O)	101.6 "	× 5½ cents	=	5.58
	Phosphoric acid (P_2O_5).....	44.8 "	× 5 cents	=	2.24

Fertilizing value of the vines = ... $34.54
Value of roots estimated as one-seventh of the vine = ... 4.99

Total fertilizing value per acre $39.53

"*Cowpea*" (*Dolichos.*) Many varieties of the cowpea are extensively cultivated at the south both for the fodder and the dried

peas, or more properly, beans, which are quite generally used as an article of food by the laboring classes. The ease with which the cowpea can be grown, its ability to withstand drouth, its valuable feeding qualities, either in a green state or cured as hay; its rank growth during the summer months which enables it to effectually smother all foul growth; its ability to draw upon the atmosphere for its supply of nitrogen and hence the improved condition in which it leaves the soil has long made the *cowpea*, to the Southern farmer what the clover is to the Western—an agricultural sheet anchor. Being a tender plant it has never been extensively cultivated far north of the limits of the cotton belt but as its value as a forage plant becomes better known it is being cultivated for feeding purposes far north of a point where it will mature seed; farmers in such localities obtaining their supply of seed from the south, where the price is usually about one dollar a bushel.

From a bushel and a half to two bushels of seed are used per acre; sown in drills about two feet (24 in.) apart and two to four seeds to the foot. In fairly good soil they will make a thick growth of from two to four feet and produce a large quantity of fodder equal in value to the best clover. At the South large quantities are cut and cured which can easily be done in their hot, dry weather. The leaves separate from the stem in curing and in our damp and cooler climate there would be some difficulty, perhaps, in getting the thick stem thoroughly dried. It would doubtless be of great value as ensilage.

It is held in high esteem at the South as a renovator of "worn out" lands. The Horticulturist of the Georgia Experiment Station speaking of green manuring says: *"The great family of leguminous plants offers a large number of species from which to select for almost any soil and climate for the purpose. While clover enjoys a luxuriant growth in the colder zones, our Southern States is the home of the cowpea, the most important plant in the

* Ga. Experiment Station, Bulletin 13, page 67.

economic system of rotation, while the value of other leguminous plants, such as vetch and lucern is already established. The roots of these plants penetrate deep into the soil, drawing their food supply from strata out of reach of most of our cultivated plants. * * * * * If turned under green they furnish the soil with an abundance of plant food, drawn from that immense storehouse—the deep sub-soil, and acquired from that inexhaustable supply—the atmosphere above. * * * * The manurial value of the cowpeas depends upon the large amount of plant food they contain, upon their power of assimilating large amounts of nitrogen from the atmosphere as well as from the soil, their ability, on account of their large root development, to penetrate deep into the sub-soil to obtain their nourishment. * * * * In the economy of farming the cowpea is therefore the most important plant as a renovator and improver of our soils, either in reclaiming our worn out lands by a judicious system of green manuring, or in maintaining its fertility by a rational method of rotation."

Prof. J. B. McBryde in an article upon The Cowpea as a Forage Crop* draws the following conclusions: "(1.) That for the production of a nitrogenous food, in the shape of a forage crop, the cowpea vines are almost without a rival. (2.) Although no digestion experiments have as yet been made with it, there is every reason to believe that this crop is equally as digestible as leguminous plants in general. (3.) That on an acre of ordinary land this crop will probably produce more digestible food than either oats or corn. (4.) The manure resulting from feeding this crop is of the highest value and should be carefully preserved and returned to the land. (5.) As the cowpea obtains a part of its nitrogen from the atmosphere, and a part, together with some of its phosphoric acid and potash, from the sub-soil, the large amount of these constituents left in its roots and stubble, and dried leaves dropped by the plant tend to enrich instead of im-

* S. C. Agricultural Experiment Bulletin No. 8, March, 1890, page 76.

poverish the soil. In other words, its power of collecting and storing fertilizing materials from sources beyond the reach of the cereals, makes the cowpea a valuable remedial crop. In addition to all this it is more than probable that the shade produced by the luxuriant growth of this crop during the summer months, when nitrification is most active, greatly promotes the formation and storage of nitrates in the soil."

For many years the idea has been prevalent among the farmers of southern New England that it does not pay to sow clover. There are perhaps two reasons for this; one being the frequent failure of clover seed to "catch," and the other the fact that the presence of clover in any quantity in loose hay injures its price in market, and as a majority of farmers sell some hay, but small quantities of *clover* seed are used in seeding. This condition of things is unfortunate for our agriculture in the light of the discovery within recent years that the *leguminous* plants are able to use the nitrogen of the atmosphere for their growth through the medium of *bacteria* infesting a *nodular* growth upon their roots. All the clovers, peas, beans, lupines, vetches, spurry, serradella, and sainfoin belong to this class and are generally cultivated for their seeds, for fodder or for green manuring. None other of our ordinary field and garden plants, grasses, cereals, root crops, vines, etc., have yet been shown to possess any such ability to assimilate atmospheric nitrogen, hence are dependent for their growth upon the supply of nitrogen within the soil and rain water, or supplied by the farmer in manure or fertilizers. When purchased, nitrogen is the most expensive element, costing more than three times as much per pound as potash and more than twice as much as phosphoric acid, hence true economy should direct the prudent farmer to invest his money in *phosphoric acid*, *potash* and the *seeds* of *leguminous plants* in so far as he can use such crops for market, for feeding or for green manuring. "The cheapest manure a farmer can use is clover seed," has become an American proverb and one in which many successful farmers in the middle

and western states have firm faith. It is a question whether here at the East the common failure of clover to "catch" may not be due to the lack of some particular element in the soil, notably *lime*. It is well known that the application of unleached wood ashes will promote the growth of clover, even cause a volunteer crop of it to spring up, "bring in clover," as the saying is. Potash has heretofore been considered *the* valuable element of wood ashes, but potash in other forms (without lime) does not produce the same effect, and it is a question whether the application of lime is not essential to a successful "catch" of clover. Knowing what we now do of the ability of the leguminous plants to feed upon the nitrogen of the atmosphere every farmer should employ as many of these "nitrogen traps" as possible. We believe the cowpea to be one that can profitably be added to the list for our State. A small quantity of three varieties was planted in the same plot with the soja bean, in drills two feet apart and about three inches apart in the drill. They were sown June 9th but might have been planted earlier,—as soon as it is safe to plant beans. The black pea is about two-fifths of an inch in length by a fourth of an inch thick and wide and black in color. Prof. Beal says* "All the plain or semi-colored varieties are of a spreading nature and are best suited for forage. The "Red Clay" and "Black" of the plain kinds and the "Whippoorwill" of the semi-colored are most esteemed. * * * * * The speckled varieties are usually bushy in growth and unfit for forage. They are raised for market and the table. For feeding stock, well cured cow-pea-hay is more nutritious than any hay produced from grasses, millet or other plants." The varieties planted made a vigorous growth from the start and were cut the last of September and fed to the cattle, who ate them with evident relish. Twenty feet of drill of each variety was cut September 27th and weighed and the percentage of water and nitrogen in the vines

*Grasses of North America, Vol. 1, page 365.

determined. The average of eight (8) analyses* to determine the feeding value is given in the table on page —— where it is easily compared with that of the soja bean and red clover. It will be seen that in protein it is richer than either and the equal of clover in fat. Its great feeding value is confirmed by analysis in addition to much practical testimony from stock men at the South who have used it for years.

Summary of Analyses of Leguminous Crops.

		Green Material.		Absolutely Dry Material.			
		Per cent. of water.	Per cent. of nitrogen.	Per cent. of nitrogen.	Yield per acre.	Dry matter per acre.	Nitrogen per acre.
Soja Beans		74.12	.55	2 11	27769 5	7186 6	152 7
Cowpeas	Black	83.27	.45	2.70	35003.5	5856.	157 5
	Blue	82.26	.39	2.19	23413.5	4153 5	91 3
	Unknown or Wonderful	84.69	.45	2.92	32397.7	4960.	145.8
Japanese Beans.	Yamagata Cha daidzu	74.48	68	2.68	17424.	4466.	118 5
	Kiyusuke daidzu	72.19	.64	2.30	20691.	5754.	132.4
	Black Podded Adzuki	81.45	.47	2.51	17424.	3232	81.9

Three of the six varieties of Japanese beans are included in the above table, as the yield per acre and per cent. of nitrogen was determined as a matter of interest in comparison with the cowpeas.

As an illustration of the actual fertilizing value of the cowpea when plowed in for green manuring we will take the nitrogen

*Analyses of American Feeding Stuffs, U. S. Gov., page 76.

analysis of the sample of the Black pea and as the potash and phosphoric acid were not determined will assume them to be the same as the average of three analyses made at the Storrs Agricultural Experiment Station, Conn., from samples grown by them. *(Potash (K_2O) 1.87 per cent. and phosphoric acid (P_2O_5) .55 per cent. in dry matter.) We then have the following calculated for the crop of *Black cowpea* per acre.

Crop cut and weighed green, 35003.........	Water....	29147 5 lbs.
	Dry Matter	5856. "

Dry Matter, 5856 lbs., contains..	Nitrogen.	157.5 lbs.	x 17½ cts. —	$27 56
	Potash (K_2O).........	..109.5 "	x 5½ cts. —	6 02
	Phosphoric acid (P_2O_5)...	32 2 "	x 5 cts. —	1 61
Fertilizing value of Cowpea vines.				$35 19

The proportion of stubble and roots to vines was determined in Connecticut and an analysis made of them. Reduced to an absolutely dry basis it is found that there is about *one-fifth* as much dry matter in the stubble and roots as in the vines and they analyze as follows†

	Nitrogen.	Phosphoric Acid. (P_2O_5)	Potash. (K_2O)
In Dry Matter.	1 51	.44	87

We would thus have one-fifth

dry matter of the vines, 1171.2 lbs., containing.....	Nitrogen........	17.71 lbs.	x 17½ cts.—	$3 10
	Potash (K_2O)...	5.15 "	x 5½ " —	26
	Phos. acid(P_2O_5)	10.19 "	x 5 " —	56
Fertilizing value of stubble and roots.				$3 92
" " vines as above				35 19
" " entire crop				$39 11

*Third Annual Report page 30.

†Average of two analyses Storrs Agricultural Experiment Station, Third Annual Report, page 33.

This was a heavy crop on land fairly well fertilized with stable manure.

A piece of exceedingly poor land surrounding a deep depression or spring hole toward the west end of the plain was sown to cowpeas with the grain drill on June 15, only sowing out of every third tube making the drills 21 inches apart. No fertilizer was applied to the field as a whole. The peas came up well and grew to an average height of about 12 inches, were plowed in and the field sown to rye. Before sowing, six one-tenth acre plots were staked out and potash in connection with different forms of phosphoric acid applied broadcast. Cowpeas were drilled directly across all the plots, June 15. On July 11th three additional plots 7, 8 and 9 were staked out just west of the first six and nitrogen applied in connection with phosphoric acid and potash and alone as a topdressing between the rows. An average row directly across each plot was pulled and weighed September 27th and nitrogen determinations made for a portion of the plots. The following table gives the amount of fertilizers applied and the yield of green vines per acre.

No. of Plot.	Kind of Fertilizer.	Pounds Fertilizer per Acre.	Pounds Green Vines per acre.
1	Dissolved S. C. Bone	390	5314
	Muriate Potash	100	...
2	Dissolved Bone Black	255	4017
	Muriate Potash	100	...
3	Dissolved Bone Black	340	5185
	Muriate Potash	100	..
4	Double Superphosphate	145	4533
	Muriate Potash	100	....
5	Floats	420	4533
	Muriate Potash	100	....
6	Slag Meal	300	4666
	Muriate Potash	100	....
7	Dissolved Bone Black	680	4925
	Muriate Potash	200	...
8	Nitrate Soda	320	....
	Muriate Potash	200	7000
	Dissolved Bone Black	680	....
9	Nitrate Soda	320	7000

The per cent. of water, dry matter and nitrogen was determined for a portion of the plots. The following table shows the dry matter and the total nitrogen per acre. The plot marked 0 was an average sample taken from the field previously mentioned and directly adjacent to the plots.

	Fertilizer applied per acre.	Average height of vines in inches.	Green Material.		Percentage of nitrogen in absolute dry matter.	Pounds green crop per acre.	Pounds dry matter per acre.	Pounds nitrogen per acre.
			Percentage of water.	Percentage of nitrogen.				
8	Dissolved Bone Black.680 Muriate Potash...... 200 Nitrate Soda 320	16	76.87	.41	1.76	7000	1619	28.7
7	Dissolved Bone Black.680 Muriate Potash......200	14	75.55	.44	1.81	4925	1204	21.7
9	Nitrate Soda 320	14	77.42	.43	1.91	7000	1581	30.1
0	Nothing Vines	10	74 68	.44	1.74	5556	1407	24.4
	Nothing Roots	......	61.59	.41	1.08	1111	427	4 3

It is claimed in regard to leguminous plants that they respond readily to the applications of potash and phosphoric acid, obtaining their supply of nitrogen from the atmosphere, but it must be constantly borne in mind that *bacterial germs* must be present to enable the plants to do this and *bacterial germs* of the *right kind*, as different leguminous plants are the home of different species of bacteria. It is quite possible that a certain leguminous plant, pea for instance, which has never been grown within the memory of man upon a certain piece of land, when at first planted there *without nitrogen may not thrive*, notwithstanding an abundant application of potash and phosphoric acid, simply because the bacteria of the pea are not present in the soil in *sufficient numbers* to enable the plants to obtain enough nitrogen to make a thrifty growth. The bacterium is the *true* "nitrogen trap" and an *abundant supply* of nodules on the roots is proof of a plentiful

7

supply of germs in the soil, while a scanty number of nodules in connection with a very yellowish green tint in the foliage indicates a scarcity of bacteria in the soil. It is highly probable that the remedy for this condition is a *repetition of the crop* thereby giving the bacteria opportunity to fill *the soil* and provide the plants with enough nitrogen to enable them to use the potash and phosphoric acid applied.

CO-OPERATIVE FIELD EXPERIMENTS WITH FERTILIZERS ON INDIAN CORN.

J. D. TOWAR.

The number of farms upon which the co-operative field experiments have been conducted during the past year has been reduced to six. Below we give names of the gentlemen who have carried on the work this season on the same fields upon which they experimented the two previous years.

Mr. Courtland P. Chapman .... Westerly.
Mr. E. F. Crowninshield .... Abbott Run.
Mr. Herbert E. Lewis .... Hope Valley.
Mr. Joseph A. Tillinghast .... Summit.
Mr. John B. Vaughan .... Noose Neck.

To which is added the field at the Experiment Station, Kingston.

The following plan shows that the arrangement of the plots and the kinds of fertilizing elements remain the same, although some radical changes have been made in the amounts of the various ingredients applied. These changes were made in accordance with the ideas obtained from the two previous years' experience, and it is very gratifying to report that the changes have, for the most part, resulted quite satisfactorily.

For the purpose of determining the maximum yield that the different elements could produce, as well as for comparison, the amount of nitrate of soda on plots 1, 4 and 5 was increased to 24 lbs. to the 1-20 acre and the application of muriate of potash and dissolved boneblack was raised to 10 lbs. and 30 lbs. to the 1-20 acre respectively. The amount of sulphate of ammonia and dried blood applied remained practically the same, the changes made

being due only to slight variations in the chemical composition of the materials in the different years.

Our fertilizing materials cost us on board the cars at Pawtucket as follows:

Nitrate of Soda	$47 00	per ton.
Sulphate of Ammonia	70 00	"
Dried Blood	35 00	"
Muriate of Potash	47 00	"
Dissolved Boneblack	25 00	"

Samples of the above materials were analyzed by our Station chemists with the following results:

ANALYSES OF FERTILIZING MATERIALS.

NITROGEN.

Sulphate of Ammonia	20.81	per cent.
Nitrate of Soda	15.66	"
Dried Blood	10.02	"

POTASSIUM OXIDE.

Muriate of Potash	50.00	per cent.

PHOSPHORIC ACID.

Dissolved Boneblack,	Soluble	15.49	per cent.
" "	Reverted	.09	"
" "	Insoluble	.00	"
" "	Total	15.58	"
Dried Blood,	"	.42	"

From the above prices and analyses of these materials, the cost of the three elements, nitrogen, potash and phosphoric acid, is found to be as follows:

Nitrogen in Nitrate of Soda	15.00	cents per lb.
" Dried Blood*	15.65	"
" Sulphate of Ammonia	16.80	"
Potash (Potassium Oxide) in muriate	4.70	"
Phosphoric Acid in dissolved boneblack	8.05	"

* Value of phosphoric acid deducted.

PLAN OF EXPERIMENTAL FIELDS.

Showing the arrangement of plots and the kind and amount of fertilizers applied. Twenty plots, each plot one-twentieth of an acre. Where possible, unmanured strips were left between the plots.

0.	No Manure.
1.	Nitrate of Soda, 24 lbs.
2.	Dissolved Boneblack, 30 lbs.
3.	Muriate of Potash, 10 lbs.
4.	Nitrate of Soda, 24 lbs.; Dissolved Boneblack, 30 lbs.
5.	Nitrate of Soda, 24 lbs.; Muriate of Potash, 10 lbs.
6.	Dissolved Boneblack, 30 lbs.; Muriate of Potash, 10 lbs. "Mixed Minerals."
7.	Mixed Minerals as No. 6, plus Nitrate of Soda, 8 lbs., $\frac{1}{3}$ Ration.
8.	Mixed Minerals as No. 6, plus Nitrate of Soda, 16 lbs., $\frac{2}{3}$ Ration.
9.	Mixed Minerals as No. 6, plus Nitrate of Soda, 24 lbs., full Ration.
6a.	Mixed Minerals. Duplicate of No. 6
10.	Mixed Minerals as No. 6, plus Sulphate of Ammonia, 6 lbs., $\frac{1}{3}$ Ration.
11.	Mixed Minerals as No. 6, plus Sulphate of Ammonia, 12 lbs., $\frac{2}{3}$ Ration.
12.	Mixed Minerals as No. 6, plus Sulphate of Ammonia, 18 lbs., full Ration.
6b.	Mixed Minerals. Duplicate of No. 6.
13.	Mixed Minerals as No. 6, plus Dried Blood, 11.5 lbs., $\frac{1}{3}$ Ration.
14.	Mixed Minerals as No. 6, plus Dried Blood, 23 lbs., $\frac{2}{3}$ Ration.
15.	Mixed Minerals as No. 6, plus Dried Blood, 34.5 lbs., full Ration.
6c.	Mixed Minerals. Duplicate of No. 6.
00.	No Manure.

TABLE SHOWING THE WEIGHT AND COST OF FERTILIZERS.

No of Plot.	Weight per Plot.	Kind of Fertilizer.	Weight per Acre.	Nitrogen per Acre.	Actual Potash per Acre.	Total Phosphoric Acid per Acre.	Cost delivered on the cars at Pawtucket per Acre.
	lbs.		lbs.	lbs.	lbs.	lbs.	
0.	0.0	Nothing	...	......	...	.. ..	.. ..
1.	24.0	Nitrate of Soda	480	75.17	..	....	$11 28
2.	30.0	Dissolved Boneblack	600	......	..	93.18	7 50
3.	10.0	Muriate of Potash	200	.....	100	......	4 70
4.	24 0 30 0	Nitrate of Soda ....480 Dissolved Boneblack 600	1080	75.17	..	93.18	18 78
5.	24 0 10.0	Nitrate of Soda ....480 Muriate of Potash 200	680	75.17	100	......	15 98
6.	30.0 10.0	Dis. Boneblack / Mur. of Potash — Mixed Minerals ...600 .. 200	800	.....	100	93.18	12 20
		Nitrate of Soda Group.					
7.	40.0 8.0	Mixed Minerals as No. 6..... 800 Nitrate of Soda, $\frac{1}{3}$ Ration. .. .160	960	25.06	100	93.18	15 96
8.	40.0 16.0	Mixed Minerals as No. 6......800 Nitrate of Soda, $\frac{2}{3}$ Ration 320	1120	50.11	100	93.18	19 72
9.	40.0 24.0	Mixed Minerals as No. 6......800 Nitrate of Soda, full Ration...480	1280	75.17	100	93.18	23 48
6a	40.0	Mixed Minerals as No. 6	800	......	100	93.18	12 20
		Sulphate of Ammonia Group.					
10.	40.0 6.0	Mixed Minerals as No 6.. .. 800 Sulph. of Ammonia, $\frac{1}{3}$ Ration..120	920	24.97	100	93.18	16 40
11.	40.0 12 0	Mixed Minerals as No. 6 .....800 Sulph. of Ammonia. $\frac{2}{3}$ Ration..240	1040	49.94	100	93.18	20 60
12.	40 0 18.0	Mixed Minerals as No. 6......8 0 Sulph.of Ammonia,full Ration,360	1160	74.92	100	93.18	24 80
6b.	40 0	Mixed Minerals as No. 6	800	......	100	93.18	12 20
		Dried Blood Group.					
13.	40 0 11.5	Mixed Minerals as No. 6......800 Dried Blood, $\frac{1}{3}$ Ration 230	1030	25.34	100	94.15	16 23
14	40.0 23 0	Mixed Minerals as No. 6......800 Dried Blood, $\frac{2}{3}$ Ration 460	1260	50.69	100	95.11	20 25
15.	40.0 34.5	Mixed Minerals as No. 6 .....800 Dried Blood, full Ration.. . 690	1490	76.04	100	96.08	24 28
6c.	40.0	Mixed Minerals as No. 6	800	.....	100	93.18	12 20
00.	00.0	Nothing	....	.. ..	...	......	.. ..

As the objects of the experiments and the descriptions of the soils remain the same, they will be quoted from the last annual report with, perhaps, a few additions.

OBJECTS OF THE EXPERIMENTS.

1. "To determine which of the three elements of plant food (nitrogen, phosphoric acid or potash) is most lacking." 2. "To test the relative fertilizing values of nitrogen in the various nitrogenous compounds, such as nitrate of soda, sulphate of ammonia and dried blood." 3. "To learn something, if possible, of the probable profit or loss from large and small applications of nitrogen to the Indian corn crop." 4. "To determine in what respects the results of this year's experiments verify the conclusions of the two former years."

A comparison of the tables and comments of the three years' experiments* is interesting, since in general the later results have been in accordance with the conclusions of the previous observations and experiments."

DETAILS OF THE INDIVIDUAL EXPERIMENTS.

KINGSTON, R. I.

THE EXPERIMENT STATION EXPERIMENT. 3RD YEAR.

"The land selected for this experiment is located on the plain at the westerly portion of the farm. The area had been in grass for many years and had become partially overgrown with moss, producing hardly enough grass to pay for the cutting. The soil to a depth of four and a half to five inches consists of a sandy loam underlaid by about two feet of yellow loam, beneath which are alternating layers of coarse sand and gravel."

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* See Third Annual Report, pages 39 to 107, and Fourth Annual Report, pages 35-81.

KINGSTON EXPERIMENT—TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

No. of Plot.	Kind of Fertilizer.	Total Yield per Plot.			Total Yield per Acre.		
		Hard Corn on the Cob.	Soft Corn on the Cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	3.5	11.5	30.	1.00	3.28	600
1.	Nitrate of Soda	3.5	18.5	38.	1.00	5.28	760
2.	Dissolved Boneblack	24.5	33.5	72.	7.00	9.57	1440
3.	Muriate of Potash	3.	19.	39.	.85	5.43	780
4.	Nitrate of Soda, Dissolved Boneblack,	76.75	38.75	89.5	21.93	11.07	1790
5.	Nitrate of Soda, Muriate of Potash,	5.75	26.	56.2	51.64	7.43	1125
6.	Dissolved Boneblack, Muriate of Potash, } Mixed Minerals,	86.75	34.5	108.75	24.78	9.85	2175
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration,	131.5	20.5	128.	37.57	5.85	2560
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration,	160.	16.5	161.5	45.71	4.71	3230
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	179.5	15.75	189.75	51.28	4.50	3795
6a.	Mixed Minerals as No. 6	107.25	20.25	107.5	30.64	5.78	2150
	Sulphate of Ammonia Group.						
10	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration,	107.	24.7	121.7	30.57	7.04	2433
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration,	25.	16.3	45.3	7.14	4.67	907
12.	Mixed Minerals as No 6, Sulph. of Ammonia, full Ration,	15.7	18.	59.7	4.47	5.14	1193
6b.	Mixed Minerals as No. 6	115.25	31.5	136.25	32.93	9.00	2725
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration,	120.	30.	133.	34.28	8.57	2660
14.	Mixed Minerals as No 6, Dried Blood, ⅔ Ration,	126.	33.	176.	36.00	9.43	5520
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	109.75	33.	132.25	31.35	9.43	2645
6c.	Mixed Minerals as No. 6	83.25	41.25	102.5	23.78	11.78	2050
00.	Nothing	00.	5.5	16 5	00.00	1.57	330

KINGSTON EXPERIMENT.

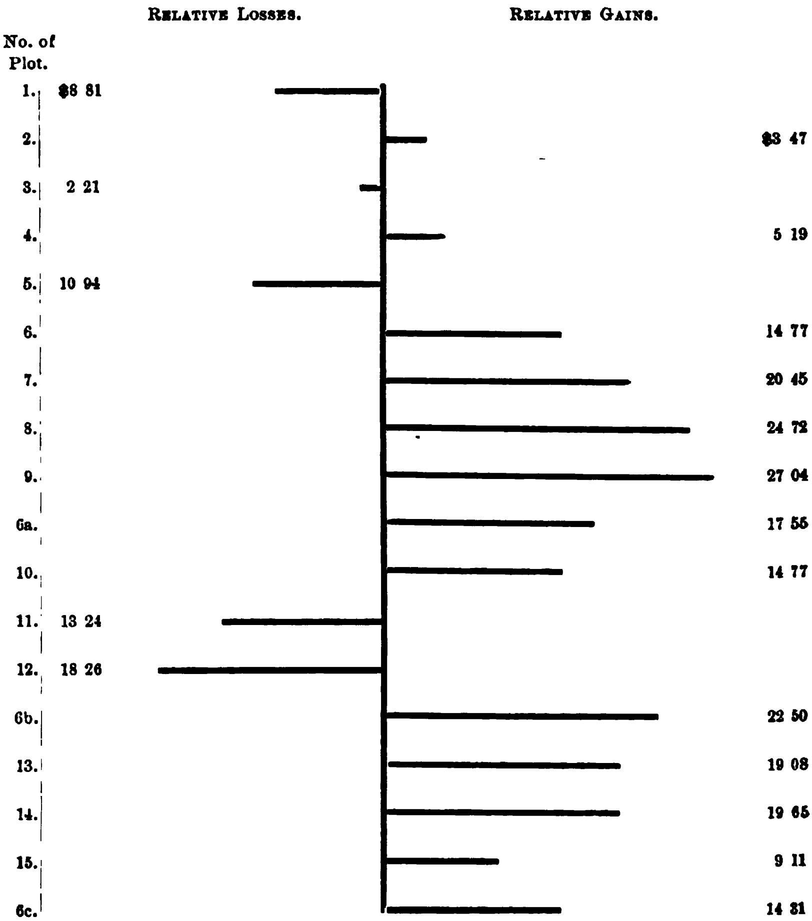
TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Stover.		Total value per acre of the corn and stover over that of the "nothing" plots.	Cost of fertilizers per acre.	Value of the crop per acre over the cost of the fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 87½c. per bush.	lbs.	Value at $7 per ton.			
1.	.50	$ 37	2 85	$1 07	295	$1 03	$2 47	$11 28	—$8 81
2.	6.50	4 87	7.14	2 68	975	3 41	10 97	7 50	3 47
3.	.35	26	3.00	1 12	315	1 10	2 49	4 70	—2 21
4.	21.43	16 07	3.64	3 24	1325	4 64	23 95	18 78	5 17
5.	1.14	85	5.00	1 87	660	2 31	5 04	15 98	—10 94
6.	24.28	18 21	7.42	2 78	1710	5 98	26 97	12 20	14 77
7.	37.07	27 80	3.42	1 28	2095	7 33	36 41	15 96	20 45
8.	45.21	33 91	2.28	85	2765	9 68	44 44	19 72	24 72
9.	50.78	38 08	2.07	78	3330	11 66	50 52	23 48	27 04
6a.	30.14	22 60	3.35	1 26	1685	5 90	29 75	12 20	17 55
10.	30.07	22 55	4.61	1 73	1968	6 89	31 17	16 40	14 77
11.	6.64	4 98	2.24	84	442	1 54	7 36	20 60	—13 24
12.	3.97	2 98	2.71	1 01	728	2 55	6 54	24 80	—18 26
6b.	32.43	24 32	6.57	2 46	2260	7 91	34 70	12 20	22 50
13	33.78	25 34	6.14	2 30	2195	7 68	35 31	16 23	19 08
14.	35.50	26 63	7.00	2 62	3055	10 69	39 94	20 25	19 69
15.	30.85	23 14	7.00	2 62	2180	7 63	33 39	24 28	9 11
6c.	23.28	17 46	9.35	3 51	1585	5 54	26 51	12 20	14 31

KINGSTON EXPERIMENT.

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



We notice in this as well in all the other fields, a decrease in the yields of the nothing plots, while the yields from all the other plots are in good proportion with the results of previous years. Therefore in deducing our conclusions we have only to repeat what has been said in the two former reports.

A glance at the yields of plots 2, 4 and 6 is sufficient to prove what has already been said of this soil, that its lack of fertilizing elements is in the following order: phosphoric acid, nitrogen, potash. In the three groups below the nitrate of soda has given the best results, followed in order by dried blood.

The peculiarly injurious effects of sulphate of ammonia noticed in the two former years are again apparent this year, and a remedy, giving very satisfactory results, has been undertaken. This condition was noticed first by Dr. H. J. Wheeler in 1890, when the experiment was begun, and at his suggestion lime was applied on a portion of the plots in 1891. The application was evidently made too late to have its desired effect. But the result of a similar application made in 1892 gave valuable evidence of the efficiency of lime in removing the difficulty. The details of this and other work in the same line will be published at a later date.

Conclusions from the Kingston experiment:

1. This soil is mostly in need of phosphoric acid, and about equally in need of potash and nitrogen. Though nitrogen gave profitable yields only when used in combination with phosphoric acid.

2. That an acid condition of the soil is very apparent.

3. That the natural supply of potash, though considerable, is not sufficient.

4. The great differences between the yields of plots 1, 3 and 5 and 2, 4 and 6 bear out the conclusions of former years that if more nitrogen had been applied the beneficial effects of the phosphoric acid would be more apparent.

5. The ill effects of sulphate of ammonia were removed by the application of lime.

WESTERLY, R. I.

2. Mr. Courtland P. Chapman's Experiment. 3rd Year.

The soil is a rich loam and slightly sandy. In 1884 the field was well fertilized with stable manure and sea-weed and planted with Indian corn. In 1885 it was fertilized with sea-weed, plowed and planted with potatoes, with "phosphate" in the hill. In the spring of 1886 it was plowed and seeded with oats; from that time until 1890 it was regularly mowed and but slightly top dressed.

WESTERLY EXPERIMENT.

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT PER ACRE.

No. of Plot.	Kind of Fertilizer.	Total Yield per Plot. Hard Corn on the Cob.	Soft Corn on the Cob.	Stover.	Total Yield per Acre. Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush	lbs.
0.	Nothing	56	24	60	16.00	6 85	1200
1.	Nitrate of Soda	80	28	72	22.85	8.00	1440
2.	Dissolved Boneblack	120	20	100	34.28	5.71	2000
3.	Muriate of Potash	88	32	108	25.14	9.14	2160
4	Nitrate of Soda, Dissolved Boneblack.	168	28	116	48.00	8.00	2320
5.	Nitrate of Soda, Muriate of Potash,	128	24	124	36.57	6.85	2480
6.	Dissolved Boneblack, Muriate of Potash, } Mixed Minerals,	136	16	140	38.85	4.57	2800
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration,	196	4	192	56.00	1.14	2800
8.	Mixed Minerals as No. 6, Nitrate of Soda, ⅔ Ration,	224	8	248	64.00	2 28	4960
9	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	260	12	292	74 28	3.42	5840
6a.	Mixed Minerals as No. 6	196	12	164	56.00	3.42	3280
	Sulphate of Ammonia Group.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration,	184	8	156	52.57	2.08	3120
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration,	220	8	156	62.85	2.28	3120
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration,	224	4	200	64.00	1.14	4000
6b.	Mixed Minerals as No. 6	152	12	156	43.42	3.42	3120
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration,	120	16	152	34.28	4.57	3040
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration,	188	8	188	53.71	2.28	3760
15.	Mixed Minerals as No 6, Dried Blood, full Ration,	196	12	224	56.00	3 42	4480
6c.	Mixed Minerals as No 6	120	16	136	34.28	4.57	2720
00.	Nothing	36	36	64	10.28	10.28	1280

WESTERLY EXPERIMENT.

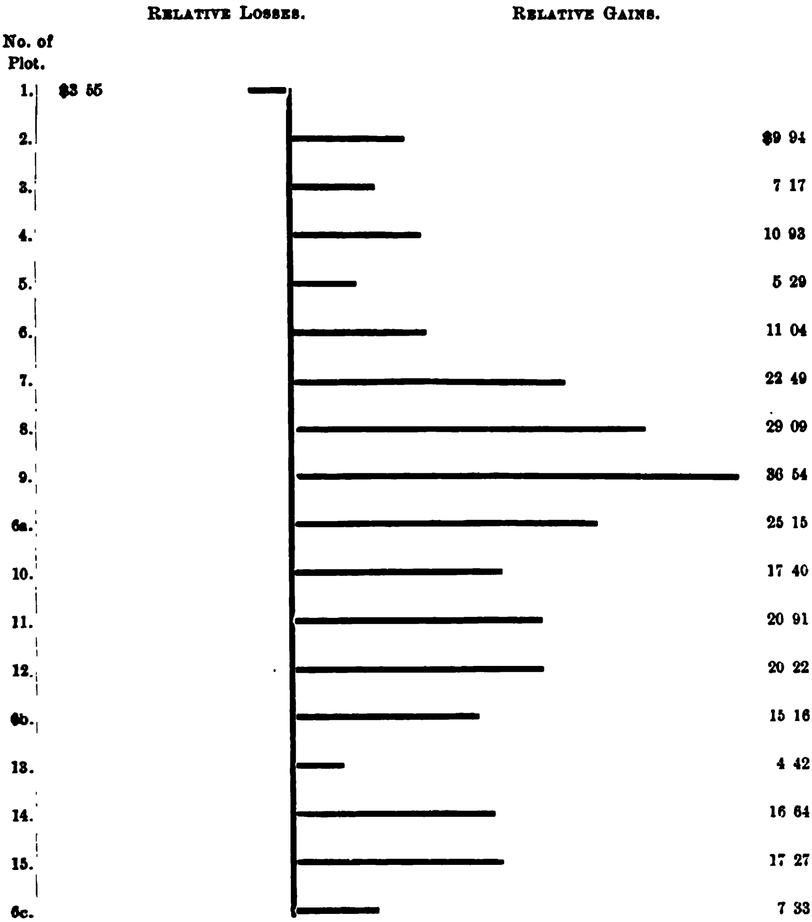
TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Stover.		Total value per acre of corn and stover over that of the nothing plots.	Cost of fertilizer per acre.	Value of crop per acre over the cost of fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c per bush.	bush.	Value at 75c per bush.	lbs.	Value at $7 per ton.			
1.	9.71	$7 28	—.57	$— 21	200	$ 70	$7 77	$11 28	$—3 51
2.	21.14	15 85	—2.86	—1 07	760	2 66	17 44	7 50	9 94
3.	12.00	9 00	.57	21	920	3 22	11 87	4 70	7 17
4.	34.86	26 15	—.57	— 21	1080	3 78	29 71	18 78	10 93
5.	23.43	17 57	—1.72	— 64	1240	4 34	21 27	15 98	5 29
6.	25.71	19 28	—4.00	—1 50	1560	5 46	23 24	12 20	11 04
7.	42.86	32 14	—7.43	—2 79	2600	9 10	38 45	15 96	22 49
8.	50.86	38 14	—6.28	—2 36	3720	13 02	48 81	19 72	29 09
9.	61.14	45 85	—5.15	—1 93	4600	16 10	60 02	23 48	36 54
6a.	42.86	32 14	—5.15	—1 93	2040	7 14	37 35	12 20	25 15
10.	36.43	29 58	—6.28	—2 35	1880	6 58	33 80	16 40	17 40
11.	49.71	37 28	—6.28	—2 35	1880	6 58	41 51	20 60	20 91
12.	50.86	38 14	—7.43	—2 79	2760	9 66	45 02	24 80	20 22
6b.	30.28	22 71	—5.15	—1 93	1880	6 58	27 36	12 20	15 16
13.	21.14	15 85	—4.00	—1 50	1800	6 30	20 65	16 23	4 42
14.	40.57	30 43	—6.28	—2 35	2520	8 82	36 89	20 25	16 64
15.	42.86	32 14	—5.15	—1 93	3240	11 34	41 55	24 28	17 27
6c	21.14	15 85	—4.00	—1 50	1480	5.18	19 53	12 20	7 33

WESTERLY EXPERIMENT.

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



The yield of corn on this field was comparatively large. The nothing plots have produced more corn and stover than in any other field of the entire experiment. Yet, with yields thus large, the product from the plots where fertilizers were applied is proportionate with the amount of necessary elements which the plots received where the proper quantity and combination was used.

From the yield of plots 1, 2 and 3 we can plainly see that phosphoric acid was the most profitable element to apply on this soil. The greater yields of 4 and 6 add proof to this conclusion.

It is evident that this soil will not give the best results from the application of a single element, nor from only two in combination, and that it is uncertain which of nitrogen or potash it is the more in need of. We can simply say that this soil responds best to a well balanced ration of all three elements, such as that of 8, 9 and 12.

General Conclusions from the Westerly Experiment.

1. The order of fertilizing elements required is: phosphoric acid, potash, nitrogen.

2. This soil responds best to a well balanced fertilizer.

3. That of the three forms of nitrogen, nitrate of soda gave the best results. Sulphate of ammonia did better than dried blood.

5. These results are materially the same as those arrived at in the two previous years.

ABBOTT RUN, R. I.

3. Mr. E. F. Crowninshield's Experiment. (3rd Year.)

In the 1890 report, the following description is made of this field: "The soil upon this field is a light sandy loam. The field was first plowed and sowed to winter rye, followed by a crop of buckwheat, which was turned under, and fertilizers applied freely. Indian corn was now planted, which proved a failure, and this was succeeded by a crop of 'round turnips.' In 1889 fertilizer was again applied, and a fair crop of 'Hungarian' was grown. No barnyard manure was ever used on the field. The land was plowed to a depth of four inches."

In the conclusions of 1890, it was stated that plots 1, 2 and 3 possessed more natural fertility than did the remainder of the field. An inspection of the following tables will show that the soil has been reduced to nearly the normal, and that the remaining plots have produced in good proportion to the amount of needed fertilizer applied.

ABBOTT RUN EXPERIMENT.

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

No. of Plot.	KIND OF FERTILIZER.	Total Yield per Plot.			Total Yield per Acre.		
		Hard Corn on Cob.	Soft Corn on the Cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	1.5	6.	27.5	.42	1.71	550
1.	Nitrate of Soda	14.	26.5	59.5	4.	7.57	1190
2.	Dissolved Boneblack	29.75	24.	91.25	8.50	6.85	1825
3.	Muriate of Potash	19.	33.	63.	5.42	9.42	1260
4.	Nitrate of Nitrate, Dissolved Boneblack,	107.5	12.5	125.	30.71	3.57	2500
5.	Nitrate of Soda, Muriate of Potash,	16.	27.	72.	4.57	7.71	1440
6.	Dissolved Boneblack, Muriate of Potash, } Mixed Minerals,	37.	15.5	122.5	10.57	4.42	2455
	NITRATE OF SODA GROUP.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ¼ Ration,	121.5	9.25	154.25	34.71	2.64	3085
8.	Mixed Minerals as No. 6, Nitrate of Soda, ¾ Ration,	137.	8.5	174.5	39.14	2.42	3490
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	142.5	7.75	174.75	40.71	2.21	3495
6a.	Mixed Minerals as No. 6	25.5	16.5	133.	7.28	4.71	2660
	SULPHATE OF AMMONIA GROUP.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ¼ Ration,	72.	16.5	136.5	20.57	4.71	2730
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ¾ Ration,	84.25	18.25	102.5	24.07	5.21	2050
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration,	101.5	17.	121.5	29.	4.85	2430
6b.	Mixed Minerals as No. 6	35.	6.5	138.5	10.	1.85	2770
	DRIED BLOOD GROUP.						
13.	Mixed Minerals as No. 6, Dried Blood, ¼ Ration,	63.	6.5	150.5	18.	1.85	3010
14	Mixed Minerals as No. 6, Dried Blood, ¾ Ration,	88.	7.5	164.5	25.14	2.14	3290
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	99.	8.75	162.25	28.28	2.50	3245
6c.	Mixed Minerals as No. 6	18.5	10.25	121.25	5.28	2.92	2425
00.	Nothing	6.75	20.	58.25	1.92	5.71	1165

ABBOTT RUN EXPERIMENT.

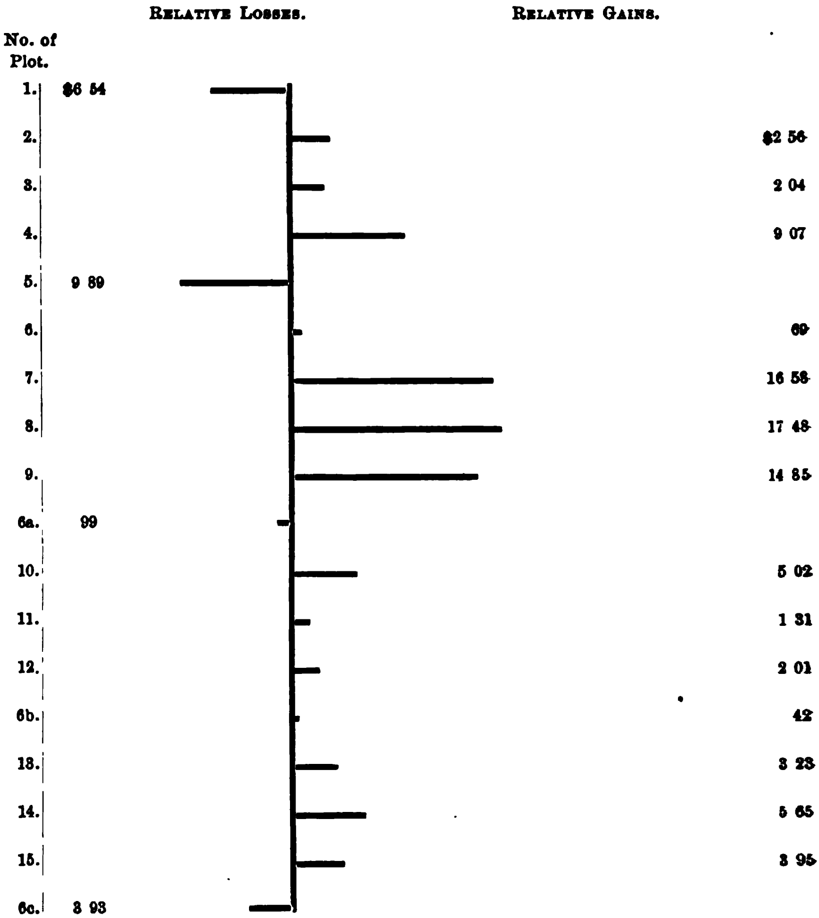
TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled corn.)		Soft Corn, shelled, (70 lbs on the cob = 1 bush. shelled corn.)		Stover.		Total value per acre of corn and stover over that of the nothing plots.	Cost of fertilizer per acre.	Value of the crop per acre over the cost of fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c per bush.	bush.	Value at 37½c per bush.	lbs.	Value at $7 per ton.			
1.	2.83	$2 12	3.86	$1 45	333	$1 17	$4 74	$11 28	$—6 54
2.	7.33	5 50	3.14	1 18	968	3 39	10 06	7 50	2 56
3.	4 25	3 19	5.71	2 14	403	1 41	6 74	4 70	2 04
4.	29.54	22 16	—.14	— 05	1643	5 75	27 85	18 78	9 07
5.	3.40	2 55	4.00	1 50	583	2 04	6 09	15 98	—9 89
6.	9.40	7 05	.71	27	1593	5 58	12 89	12 20	69
7.	33.54	25 15	—1.07	— 41	2228	7 80	32 54	15 96	16 58
8.	37.97	28 48	—1.29	— 48	2633	9 22	37 20	19 72	17 48
9.	39.54	29 66	—1.50	— 56	2638	9 23	38 33	23 48	14 85
6a.	6.11	4 58	1.00	32	1803	6 31	11 21	12 20	— 99
10.	19.40	14 65	1.01	32	1873	6 56	21 42	16 40	5 02
11.	22.90	17 18	1.50	56	1193	4 18	21 91	20 60	1 31
12.	27.83	20 87	1.14	43	1573	5 51	26 81	24 80	2 01
6b	8.83	6 62	—1.86	— 70	1913	6 96	12 62	12 20	42
13.	16.83	12 62	—1.86	— 70	2153	7 54	19 46	16 23	3 23
14.	23.93	17 98	—1.57	— 59	2433	8 52	25 90	20 25	5 65
15.	27.11	20 33	—1.21	— 45	2388	8 36	28 23	24 28	3 95
6c.	4.11	3 08	—.79	— 30	1568	5 49	8 27	12 20	—3 93

ABBOTT RUN EXPERIMENT.

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



The very light yields of plots 0 and 00 make the showing for the other plots very good as compared with the yields of former years. It is evident from these tables, that this soil is mostly deficient in phosphoric acid, followed in order by nitrogen and potash.

The value of nitrate of soda to this soil is plainly shown by the yields of plots 4, 7, 8 and 9, while in all the plots where both nitrogen and phosphoric acid was applied in quantities exceeding the former applications, the yields have been materially greater and more profitable; thus proving the truth of our previous conclusions in regard to these important elements.

Referring to the special nitrogen tests, nitrate of soda has again shown its superior value. Although sulphate of ammonia and dried blood produced about equal yields of hard corn, the dried blood gave a better yield of stover and, upon the whole, yielded a more profitable crop.

Looking at the mixed mineral plots, it will be seen that the yields of hard corn are extremely light, while of stover the yield is fairly good. Yet the average money value of the crop from these plots, after deducting the cost of fertilizers, is less than that of the nothing plots.

General Conclusions from the Abbott Run Experiment.

1. This soil's deficiency is in the following order: . Phosphoric Acid, Nitrogen, Potash.

2. Of the three forms of nitrogen, nitrate of soda gave the best results. Dried blood gave yields a little better than sulphate of ammonia.

3. The average yield of the mixed mineral plots, above the yield of the nothing plots, was not sufficient to pay for the extra cost of fertilizers.

HOPE VALLEY, R. I.

4. Mr. Herbert E. Lewis' Experiment. (3rd Year.)

"This soil was a sandy loam, and the field had served for several years as a cow pasture." It was very noticeable that the corn on the nitrate of soda plots was much greener than any of the rest of the experiment, and that plot 5 was the least ripe of any. The same condition was noticed in the Westerly experiment.

HOPE VALLEY EXPERIMENT—TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

No. of Plot.	Kind of Fertilizer.	Total Yield per Plot.			Total Yield per Acre.		
		Hard Corn on the Cob.	Soft Corn on the Cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	3.2	13.0	33.0	.94	3.75	667
1.	Nitrate of Soda	4.0	13.0	32.5	1.14	3.73	654
2.	Dissolved Boneblack	16.7	23.0	53.5	4.81	6.61	1076
3.	Muriate of Potash	13.5	23.5	41.2	3.90	6.78	834
4.	Nitrate of Soda, Dissolved Boneblack,	77.2	21.5	73.2	22.20	6.17	1473
5.	Nitrate of Soda, Muriate of Potash,	10.0	18.2	46.0	2.88	5.27	930
6.	Dissolved Boneblack, Muriate of Potash, } Mixed Minerals,	38.5	16.5	74.7	11.00	4.71	1495
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ¼ Ration,	84.2	19.2	110.2	24.20	5.53	2217
8.	Mixed Minerals as No. 6, Nitrate of Soda, ¾ Ration,	125.0	11.2	145.5	36.10	3.24	2942
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	122.0	10.0	117.0	35.23	2.88	2366
6a.	Mixed Minerals as No. 6	33.0	16.2	94.2	10.54	3.75	1673
	Sulphate of Ammonia Group.						
10	Mixed Minerals as No. 6, Sulph. of Ammonia, ¼ Ration,	83.0	9.0	102.5	23.71	2.57	2050
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ¾ Ration,	47.5	22.5	71.2	13.80	6.53	1449
12.	Mixed Minerals as No 6, Sulph. of Ammonia, full Ration,	62.5	26.7	101.7	17.85	7.64	2035
6b.	Mixed Minerals as No. 6	36.5	13.0	82.7	10.54	3.75	1673
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ¼ Ration,	78.2	14.5	111.5	22.48	4.17	2242
14.	Mixed Minerals as No 6, Dried Blood, ¾ Ration,	101.7	15.2	128.5	29.07	4.35	2570
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	93.5	16.0	120.5	26.85	4.60	2423
6c.	Mixed Minerals as No. 6	37.7	21.7	84.0	10.95	6.31	1708
00.	Nothing	8.5	22.7	37.7	2.42	6.50	755

HOPE VALLEY EXPERIMENT.

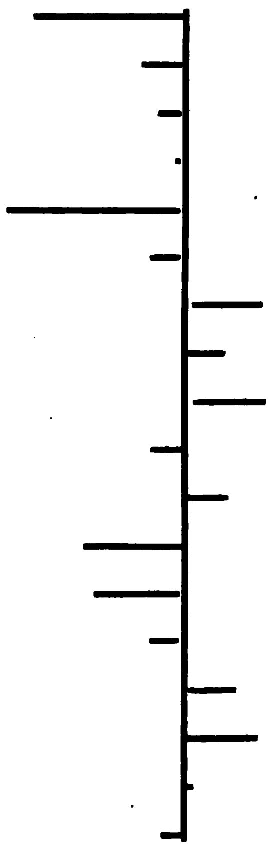
TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Stover.		Total value per acre of the corn and stover over that of the "nothing" plots.	Cost of fertilizers per acre.	Value of the crop per acre over the cost of the fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 87½c. per bush.	lbs.	Value at $7 per ton.			
1.	—.54	$— 40	—1 39	$—52	—57	$— 20	$—1 12	$11 28	$—12 40
2.	3.13	2 35	1.49	56	365	1 28	4 18	7 50	—3 32
3.	2.22	1 66	1.66	62	123	43	2 71	4 70	—1 99
4.	20.52	15 39	1.05	40	762	2 67	18 45	18 78	—33
5.	1.20	90	.15	06	219	76	1 72	15 98	—14 26
6.	9.32	6 99	—.41	— 15	784	2 74	9 58	12 20	—2 62
7.	22.52	16 89	.41	15	1506	5 27	22 32	15 96	6 36
8.	34.42	25 81	—1.88	— 70	2231	7 81	32 92	19 72	3 20
9.	33.55	25 16	—2.24	— 84	1655	5 79	30 13	23 48	6 65
6a.	7.75	5 81	—.48	— 18	1174	4 11	9 74	12 20	—2 46
10.	22.03	16 52	—2.55	— 96	1339	4 69	20 24	16 40	3 84
11.	12.12	9 09	1.41	53	738	2 58	12 20	20 60	—8 40
12.	16.17	12 13	2.52	94	1324	4 63	17 71	24 80	—7 09
6b.	8.86	6 64	—1.37	— 52	962	3 37	9 49	12 20	—2 71
13	20.80	15 60	—.95	— 36	1531	5 36	20 60	16 23	4 37
14.	27.39	20 54	—.77	— 29	1859	6 51	26 76	20 25	6 51
15.	25.17	18 88	—.52	— 19	1712	5 99	24 68	24 28	40
6c.	9.27	6 95	1.19	45	997	3 49	10 89	12 20	—1 31

HOPE VALLEY EXPERIMENT.

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



No. of Plot.	Relative Losses.	Relative Gains.
1.	$12 40	
2.	8 32	
3.	1 99	
4.	33	
5.	14 26	
6.	2 62	
7.		$6 36
8.		3 20
9.		6 65
6a.	2 46	
10.		3 84
11.	8 40	
12.	7 09	
6b.	2 71	
13.		4 37
14.		6 51
15.		40
6c.	1 31	

The yields from this field show a great decrease in product since 1892; in many of the plots it being less than half of last year's yield and in none does it equal.

The relative efficiency of the various ingredients remains the same, while plots yield in about the same proportion of former years. The great falling off in yield of plots 11 and 12 have an important bearing upon the sulphate of ammonia question which will be treated elsewhere.

We hope to continue this and others of these experiments another year when an application of lime will be made to a portion of these plots. Our summary is in part a repetition of 1892.

General Conclusions from the Hope Valley Experiment.

1. This soil seems to be very deficient in phosphoric acid and considerably so in nitrogen.

2. In the special nitrogen tests, nitrogen in the form of nitrate of soda gave the best results and dried blood proved better than sulphate of ammonia.

3. The application of fertilizers was unaccompanied with profit where only one or two elements were applied and in the $\frac{2}{3}$ and full ration of sulphate of ammonia plots the yield was not commensurate with the cost, thus leading us to suspect a condition similar to that found with the Kingston sulphate of ammonia plots.

SUMMIT, R. I.

5. Mr. Joseph A. Tillinghast's Experiment. (3d Year.)

"This field constituted a part of an old pasture which had not been plowed in 25 years. The exposure was a southerly one, the slope being from 0 to 00 plots. The soil upon plots 1, 2 and 3 was a light sandy loam, and that of the following ones being gravelly, excepting 0, which was sandy loam."

The following is the tabulated yields.

SUMMIT EXPERIMENT.

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

No. of Plot.	Kind of Fertilizer.	Total Yield per Plot.			Total Yield per Acre.		
		Hard Corn on the Cob.	Soft Corn on the Cob.	Stover.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	0 0	2.4	20.5	0.00	.68	410
1.	Nitrate of Soda	0.0	2.7	22.7	0.00	.78	455
2.	Dissolved Boneblack	16 9	16.9	53 5	4.84	4.84	1070
3.	Muriate of Potash	11.2	15.2	43 0	3.19	4.34	860
4	Nitrate of Soda, Dissolved Boneblack,	132.7	16.9	96.0	37.93	4.84	1920
5.	Nitrate of Soda, Muriate of Potash,	10.9	8.2	47.0	3.11	2.34	940
6.	Dissolved Boneblack, Muriate of Potash, } Mixed Minerals,	53.2	17.4	117.5	14.89	4.91	2350
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ½ Ration,	101.6	12 5	135.5	29.01	3.55	2710
8.	Mixed Minerals as No. 6, Nitrate of Soda, ¾ Ration,	141.2	18.2	155.5	40.35	5.19	3110
9	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	174.2	12.7	183.5	49 78	3.62	3670
6a.	Mixed Minerals as No. 6	69.4	11.4	147.5	19.82	3.27	2950
	Sulphate of Ammonia Group.						
10.	Mixed Minerals as No. 6, Sulph. of Ammonia, ½ Ration,	127.6	5.6	167.5	36.44	1.60	3350
11.	Mixed Minerals as No. 6, Sulph. of Ammonia, ¾ Ration,	169.7	5.3	175.5	48.50	1.52	3510
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration,	162.2	10 2	183.5	46.35	2.91	3670
6b.	Mixed Minerals as No. 6	31.7	10.7	129.5	9.05	3.05	2590
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ½ Ration,	89.9	12.7	141.5	25.68	3.62	2830
14.	Mixed Minerals as No. 6, Dried Blood, ¾ Ration,	110.6	16.4	155.5	31.59	4.69	3110
15.	Mixed Minerals as No 6, Dried Blood, full Ration,	133.1	16.7	189.5	38.02	4 77	3790
6c.	Mixed Minerals as No. 6	65.4	12 7	133.5	18 68	3.62	2670
00.	Nothing	43.2	14.7	71.5	12.34	4.19	1430

SUMMIT EXPERIMENT.

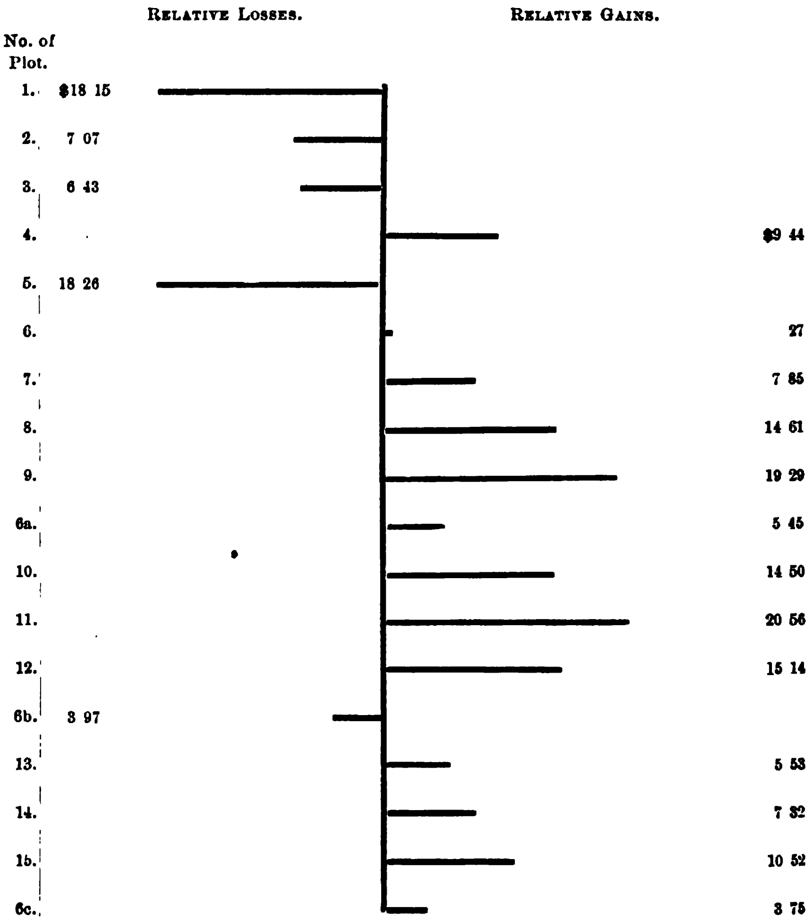
TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.) bush.	Hard Corn, Value at 75c per bush.	Soft Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.) bush.	Soft Corn, Value at 87½c per bush.	Stover. lbs.	Stover. Value at $7 per ton.	Total value per acre of corn and stover over that of the nothing plots.	Cost of fertilizer per acre.	Value of crop per acre over the cost of fertilizers. A minus (—) sign indicates a loss.
1.	—6.17	$—4 63	—1.66	$— 62	—465	$—1 63	$—6 87	$11 28	$—18 15
2.	—1.33	—1 00	2.40	90	150	53	43	7 50	—7 07
3.	—2.98	—2 34	1.90	71	—60	—21	—1 73	4 70	—6 43
4.	31.76	23 82	2.40	90	1000	3 50	28 22	18 78	9 44
5.	—3.08	—2 31	—.10	— 04	20	07	—2 28	15 98	—18 26
6.	8.72	6 54	2.47	93	1430	5 01	12 47	12 20	27
7.	22.84	17 13	1.11	42	1790	6 27	23.81	15 96	7 85
8.	34.18	25 64	2.75	1 03	2190	7 67	34 33	19 72	14 61
9.	43.61	32 71	1.18	44	2750	9 63	42 77	23 48	19 29
6a.	13.65	10 24	.83	31	2030	7 11	17 65	12 20	5 45
10.	30.27	22 70	—.84	— 31	2430	8 51	30 90	16 40	14 50
11.	42.33	31 75	—.92	— 35	2590	9 07	41 16	20 60	20 56
12.	40.18	30 14	.47	18	2750	9 63	39 94	24 80	15 14
6b.	2.88	2 16	.61	23	1670	5 85	8 23	12 20	—3 97
13.	19.51	14 63	1.18	44	1910	6 69	21 76	16 28	5 53
14.	25.42	19 07	2.25	84	2190	7 67	27 57	20 25	7 32
15.	31.85	23 89	2.33	87	2870	10 05	34 80	24 28	10 52
6c	12.51	9 38	1.18	44	1750	6 13	15 95	12 20	3 75

SUMMIT EXPERIMENT.

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



In computing our results the two former years we have not deducted the average of the nothing plots from the yields of the remaining plots as we do in this report, and owing to the fact that the 00 plot was so situated that it received the wash from several of the plots above it, the results of comparisons with its yield are of little value.

It will be seen, however, that the yields of the various plots with the exception of plot 11 are directly proportional to the amount of fertilizing elements applied.

It will be seen that the soil has responded precisely in proportion to the amount of fertilizing elements; that the results of the former experiments have taught us that this soil needed phosphoric acid to a considerable extent and that very profitable yields were produced only when the three fertilizing elements were applied.

Sulphate of ammonia with minerals. ⅔ ration, has again produced the most profitable yield, though nitrate of soda, full ration, (No. 9) produced the most hard corn.

We quote from last year's report the

General Conclusions from the Summit Experiment.

1. "This soil was most deficient in phosphoric acid."

2. Potash seemed to be a trifle more deficient than nitrogen. Neither, alone or together, produced profitable yields, but either or both in combination with phosphoric acid gave large yields.

3. The value of the materials used in the special nitrogen test (plots 7-15) is in the following order: Sulphate of ammonia, nitrate of soda, dried blood.

NOOSE NECK, R. I.

6. Mr. John B. Vaughan's Experiment. (3d Year.)

The following description of this soil was given in 1890 by Dr. Wheeler when the experiment was begun:

"The soil was a poor sandy loam and the field had not been plowed nor fertilized since 1884; the crop grown at that time being fodder-corn manured in the drill.

"In many places there was little or no sod, and at the time the field was surveyed and plotted there was almost nothing growing upon it save bluets (Houstonia caerulea) and bird foot violets (Viola pedata.)

"Several isolated clusters of common blue lupine (Lupinus perennis) were to be seen growing profusely. This plant is generally found on neglected, sandy fields and by sandy roadsides, and belongs to the family of plants known as 'Leguminosae,' the lupine and several other members of which have been shown by Atwater, Hellriegel and others to be able to draw their supply of nitrogen from the air.

"As will be seen from the tables which follow, this soil appeared to be decidedly deficient in nitrogen, but, nevertheless the lupine, one of the class of plants richest in nitrogen, was able to attain development. This was a good object lesson, showing that Nature provides for herself, for this plant was at work probably gathering nitrogen from the air and thus furnishing to the soil by its decay the most costly of the lacking elements. To the same end other of the lupines, the horse-bean and cow-pea have been introduced for use in green manuring."

The corn on the plots where no nitrogen was applied was of a yellowish, sickly color while that which received nitrogen had a green, healthy color, even on plots 1 and 5 where the corn was very light. The entire field shows that it had not received a sufficient amount of rain.

This may account for the light yields of the sulphate of ammonia and dried blood plots. In the Director's report attention has already been called to the fact that less rain fell during the past year than in either of the two preceding years.

11

NOOSE NECK EXPERIMENT.

TABLE SHOWING THE KIND OF FERTILIZER AND YIELDS PER PLOT AND PER ACRE.

No. of Plot.	Kind of Fertilizer.	Total Yield per Plot. Hard Corn on the Cob.	Soft Corn on the Cob.	Stover.	Total Yield per Acre. Hard Corn shelled, (70 lbs. on the cob = 1 bush. shelled.)	Soft Corn shelled, (70 lbs. on the cob = 1 bush. shelled.)	Stover.
		lbs.	lbs.	lbs.	bush.	bush.	lbs.
0.	Nothing	7 75	5.	36.	2.21	1.42	720
1.	Nitrate of Soda	12.	16.5	47.	3.42	4.71	940
2.	Dissolved Boneblack	10.25	10.	60.	2.92	2.85	1200
3.	Muriate of Potash	5.75	13.25	71.5	1.64	3.78	1430
4.	Nitrate of Soda, Dissolved Boneblack,	130.5	27.75	127.25	37 28	7.92	2545
5.	Nitrate of Soda, Muriate of Potash,	32.5	34.5	79.	9.28	9.85	1580
6.	Dissolved Boneblack, Muriate of Potash, } Mixed Minerals,	24.25	9 25	104 75	6.92	2.64	2095
	Nitrate of Soda Group.						
7.	Mixed Minerals as No. 6, Nitrate of Soda, ⅓ Ration,	52.	22.	150.5	14.85	6.28	3010
8.	Mixed Minerals as No. 6, Nitrate of Soda ⅔ Ration,	91.25	18.75	141.	26 07	5.35	2820
9.	Mixed Minerals as No. 6, Nitrate of Soda, full Ration,	125.	15.	173.	35.71	4.28	3460
6a.	Mixed Minerals as No. 6	26.5	8.25	115.25	7.57	2 35	3460
	Sulphate of Ammonia Group.						
10	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅓ Ration,	48.25	11.	144.75	13.78	3.14	2895
11	Mixed Minerals as No. 6, Sulph. of Ammonia, ⅔ Ration,	58.75	16.75	117.5	16.78	4.78	2350
12.	Mixed Minerals as No. 6, Sulph. of Ammonia, full Ration,	73 5	15.5	146.	21.00	4.42	2920
6b.	Mixed Minerals as No. 6	8.	7.	94.	2.28	2.00	1880
	Dried Blood Group.						
13.	Mixed Minerals as No. 6, Dried Blood, ⅓ Ration,	16.25	8.	118.75	4.64	2.28	2375
14.	Mixed Minerals as No. 6, Dried Blood, ⅔ Ration,	31.	12.	136.	8.85	3.42	2720
15.	Mixed Minerals as No. 6, Dried Blood, full Ration,	75.25	12.	146.75	21 50	3.42	2935
6c.	Mixed Minerals as No. 6	17.75	11	111.25	5 07	3.14	2225
00.	Nothing	18.	18.	48.	5.14	5.14	960

NOOSE NECK EXPERIMENT.

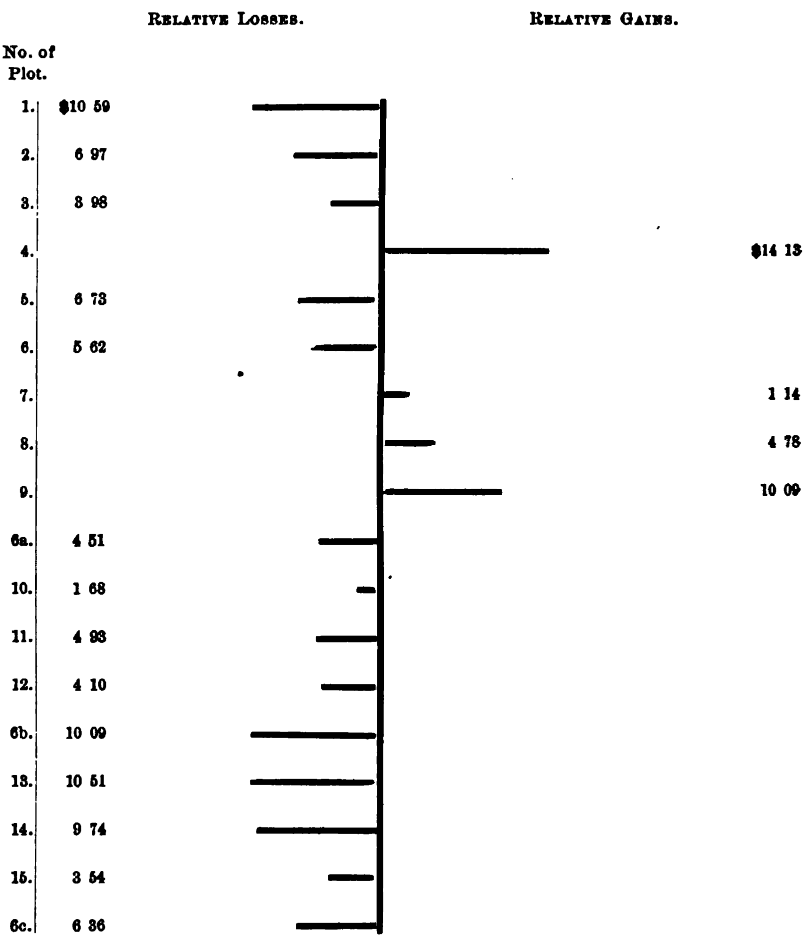
TABLE SHOWING THE INCREASE IN AMOUNT AND VALUE OF THE PRODUCT PER ACRE OVER THE AVERAGE OF THE "NOTHING" PLOTS.

Where the amount and value is below the average of the "Nothing" plots it is shown by a minus (—) sign.

No. of Plot.	Hard Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Soft Corn, shelled, (70 lbs. on the cob = 1 bush. of shelled corn.)		Stover.		Total value per acre of corn and stover over that of the "nothing" plots.	Cost of fertilizers per acre.	Value of crop per acre over the cost of fertilizers. A minus (—) sign indicates a loss.
	bush.	Value at 75c. per bush.	bush.	Value at 87½c. per bush.	lbs.	Value at $7 per ton.			
1.	—.26	$— 20	1.43	$ 54	100	$ 35	$ 69	$11 28	$—10 59
2.	—.76	— 57	— 43	— 16	860	1 26	.53	7 50	—6 97
3.	—2 04	—1 53	.50	19	590	2 07	72	4 70	—3 98
4.	33.60	25 20	4.64	1 74	1705	5 97	32 91	18 78	14 13
5.	5.60	4 20	6 57	2 46	740	2 59	9 25	15 98	—6 73
6.	3 24	2 43	—.64	— 24	1255	4 39	6 58	12 20	—5 62
7.	11.17	8 38	3.00	1 13	2170	7 60	17 10	15 96	1 14
8.	22.39	16 79	2.07	78	1980	6 93	24 50	19 72	4 78
9.	32.03	24 02	1.00	38	2620	9 17	33 57	23 48	10 09
6a.	3.89	2 92	—.93	— 35	1465	5 13	7 69	12 20	—4 51
10.	10.10	7 58	—.14	— 05	2055	7 19	14 72	16 40	—1 68
11.	13.10	9 83	1.50	56	1510	5 29	15 67	20 60	—4 93
12.	17.32	12 99	1.14	43	2080	7 28	20 70	24 80	—4 10
6b.	—1.40	— 1 05	—1.28	— 48	1040	3 64	2 11	12 20	—10 09
13.	.96	72	—1.00	— 37	1535	5 37	5 72	16 23	—10 51
14.	5.17	3 88	.14	05	1880	6 58	10 51	20 25	—9 74
15.	17.82	13 37	.14	05	2095	7 33	20 74	24 28	—3 54
6c.	1.39	10 42	—.14	— 05	1385	4 85	5 84	12 20	—6 36

NOOSE NECK EXPERIMENT.

FROM THE LAST COLUMN OF THE PRECEDING TABLE, SHOWING BY A COMPARATIVE SCALE THE FINANCIAL GAIN OR LOSS PER ACRE FROM THE USE OF CHEMICALS.



It will be noticed that in plots 4, 7, 8 and 9, only, was there a profitable yield and yet, for this soil, the yields of plots 10, 11, 12 and 15 were quite good, though not sufficient to pay for the fertilizer applied.

General Conclusions from the Noose Neck Experiment.

1. This soil was greatly lacking in phosphoric acid and nitrogen. It was apparently most in need of nitrogen.

2. The yield of hard corn on plot 4, leads us to conclude that with a good supply of nitrogon in the form of nitrate and available phosphoric acid there is little need of much potash.

3. Nitrate of soda gave far the best results, while sulphate of ammonia and dried blood did not produce yields commensurate with their cost.

General Results of the Experiments.

To give a thorough review of the results would be to simply reiterate all that was given in the report of one year ago with, perhaps, a few more conclusions that this year's experiment has brought to view, as follows :

1. The past year's experiment has given us no occasion to wish the withdrawal of a single statement made in the two former reports.

2. Phosphoric acid has in every case proven itself the most deficient, followed by nitrogen.

3. In the special nitrogen tests, nitrate of soda takes first place in five cases and sulphate of ammonia in one. Nitrate of soda takes second place in one case, dried blood in three and sulphate of ammonia in two.

4. The ill effects of sulphate of ammonia were wholly prevented by the application of lime.

I take this opportunity to thank the Director and the chemist of the Station for valuable aid in planning the work and compiling these results and also to acknowledge my appreciation of the kindness, care and interest of the gentlemen who have conducted the work.

CHEMICAL DIVISION.

H. J. WHEELER.

The equipment of the chemical laboratory remains essentially the same as stated in my last annual report.

The work of the Division for the year has been somewhat varied, as will be seen by a perusal of the report.

THE FERTILIZER CONTROL.

On the 20th of April, 1892, the General Assembly passed an act entitled: "*An Act in amendment of Chapter 584 of the Public Laws, entitled, 'An Act in relation to commercial fertilizers.'*"

Under the provisions of this act it was made the duty of the chemist of this station, or his deputy, to collect and analyze such samples of "fertilizing materials as are subject to the conditions of this act, which may from time to time be sold, offered or exposed for sale in this State." The Director of this Station is also authorized to "cause the results of the analyses of fertilizers collected under this act to be published, and issue the results to the farmers of the State as rapidly as the progress of the work will allow, together with the comparative commercial value per ton; and such other additional information as circumstances may advise."

In accordance with the above provisions, my assistant or myself visited nearly every section of the State with the purpose of

making a thorough inspection. We have thus collected and analyzed 106 fertilizing materials which were found on sale, 103 of which represent distinct brands, or in case of agricultural chemicals, distinct dealers. During the preceding season 69 samples were analyzed and in 1890, before the work was done by this Station, but 51 samples were analyzed. Formerly the analyses which were made, were very incomplete, and in many cases sufficient data were not obtained to give a definite idea, either of the agricultural, or commercial, value of the fertilizers in question. Since the work has been done at this Station, it has been my aim to make the analyses of fertilizers as complete as possible, so that the farmer could gain a good idea of their commercial value and their adaptability to the production of special crops. Such a course has largely increased the volume of the chemical work to be done, as will be seen by the following: The number of determinations made in 1890 was but 153, in 1891 the number amounted to 561, and the past season to 756. Four bulletins on fertilizers have been published during the year, copies of which have been sent free to all farmers in the State who have applied for them, or whose names were on the Station mailing list. Bulletin No. 16, May, 1892, contained a copy of the new fertilizer law, the average selling price of fertilizer stock for the six months preceding March 1, 1892, an explanation of the terms used, analyses of commercial fertilizers collected under the fertilizer control and of samples of wood ashes and ground bones which were sent for analysis from various sections of the State. Bulletin No. 17, June, 1892, contained the analyses of commercial fertilizers, fish pomace, acidulated bone and ground bones collected under the fertilizer control, and called attention to a *Sheep Fertilizer*, which was being sold at Newport for $50.00 per ton, or at the rate of $80.00 per ton in 100 pound lots, the nitrogen, phosphoric acid and potash of which, could have been bought in the form of dry and fine ground fish, meat and blood, in dry ground fish, fine bone and tankage, and in high grade sulphate of potash, for $10.67. Bulletin No. 18, Aug.,

1892, contained analyses of 29 commercial fertilizers collected under the fertilizer control and also a few words of caution to the farmers of the State, in the purchase of wood ashes. Bulletin No. 19, September, 1892, concluded the analyses of commercial fertilizers, wood ashes, muriate of potash, and nitrate of soda, collected under the fertilizer control during 1892, excepting three samples of Canada unleached hard wood ashes, which were collected toward the close of the year, and which are embodied in my report to the State Board of Agriculture for 1892. This Bulletin also contains a general review of the fertilizer inspection for the year.

EXAMINATION OF "SEA-WEEDS."

During the winter and autumn three collections of sea-weeds were made, and those species found on our coast, which are of chief value as fertilizers, were analyzed. Photographs of the same were also obtained, which have been used for illustrations. In connection with these analyses and illustrations of the sea-weeds, a popular treatise on the value and methods of applying sea-weeds in agriculture, has been prepared, and the whole is now in the hands of the printer and will soon be issued as Bulletin No. 21.

CONTRIBUTION TO THE STATION EXHIBIT AT THE WORLD'S COLUMBIAN EXPOSITION.

The Experiment Stations of the United States are to make an exhibit at the Columbian Exposition, and the Chemical Division of this Station was requested to make a contribution. In accordance with this plan I have set about the preparation of a collection of dried specimens of such sea-weeds as are used for manurial purposes on our coast, which are to be accompanied by chemical analyses. A collection of the waste manurial products of Rhode Island Industries will be analyzed and form a part of the exhibit, including wool-waste, cotton-waste, waste from the

treatment of the garbage of the city of Providence by the "Simonin process," dried blood, tankage, bone, etc., from the works of the L. B. Darling Fertilizer Co., of Pawtucket, fish-waste such as produced by Daniel T. Church and W. J. Brightman & Co., at Tiverton, etc.

Samples of soils from various sections of the State, showing the soil in its natural position to a depth of three feet from the surface, have also been collected, are now being analyzed, and will form the balance of the exhibit contributed by this Division.

CORRESPONDENCE.

Since the organization of the Station, an increasing number of questions in relation to how to mix, apply, and compound agricultural chemicals and fertilizer stock, have been answered. All such information has been furnished, without expense, to those applying, and the result seems to be an awakened interest in this important question. There is no question but that thousands of dollars are wasted annually by the farmers of this State, on account of methods pursued in purchasing fertilizers. I will repeat here what has already been said in Bulletins 17 and 19, and which cannot be too often repeated, or too strongly emphasized, viz: *Rhode Island farmers cannot expect to grow more crops at a lower price, until they pay more attention to the needs of the crop and soil, and the chemical composition of the various fertilizers. The question is not, how many pounds of fertilizer for the money, but how much potash, phosphoric acid and nitrogen, and their form.*

Heretofore there have been several manufacturers selling commercial fertilizers within the State, who have not paid to the State the full amount of the fees required by law, and certain parties have never paid any fee. The duty of attending to this matter properly devolved upon the Secretary of the State Board of Agriculture, but at the time when it required attention, the former Secretary, David S. Collins, tendered his resignation, and the Board was practically without a Secretary. In the meantime, I devoted

myself to the duty of securing the payment of these fees, which involved, in certain cases, quite an extended correspondence. Later, Geo. A. Stockwell was elected Secretary of the State Board of Agriculture and the work was transferred to his hands. The result of our mutual efforts has been, that the State has secured the payment of fees, under the act, to the extent of several hundred dollars more than ever before, and almost wholly from parties without the State.

MISCELLANEOUS WORK.

In response to requests from various sections of the State, quite a number of materials have been analyzed gratis. This is always done where the results of the work seem to be of value to a sufficient number of farmers to warrant it, and with the understanding that the Station reserves the right to publish the results for the benefit of others.

Analyses of various materials have also been made for some of the other Divisions of the Station.

My time has been somewhat encroached upon by attending hearings before committees of the General Assembly, on fertilizer bills; the preparation and delivery of lectures on agricultural topics, in collecting samples of soil, etc., to be sent to the Columbian Exposition, and in connection with the experimental work of the Agricultural Division.

NEEDS OF THE CHEMICAL DIVISION.

For the purpose of making this Division as effective as it should be, it is absolutely necessary that the other wing of the laboratory, now used by the College, should be vacated and thus be made available for the chemical work of the Station. There are certain chemical determinations, necessary in connection with experimental work which it seems very desirable to conduct at the Station, which cannot well be made in the same room where general laboratory work is in progress and where the air is continually

being contaminated with acid and ammonia fumes. So much work is now crowded into the narrow limits of the present laboratory, that there is not ample space for setting up the apparatus for all the determinations which are required. In order to accomplish as much as possible with the smallest expense, and to enable the Chemical Division to do valuable work in certain lines of investigation, it seems imperative that such changes should be made as soon as circumstances will allow.

MISCELLANEOUS ANALYSES.*

The following miscellaneous analyses have not been published in previous bulletins and reports: Nos. 62-71, inclusive, analyses of sulphate of ammonia, nitrate of soda, dried blood, muriate of potash and dissolved boneblack, which may be found in this report and the one for 1891, under the head of "*Co-operative Field Experiments with fertilizers on Indian corn.*" No. 72, An analysis of poultry food from the Poultry Division, to be published by that Division. No. 73, An analysis of the stomach of a cow which was supposed to have died from poisoning, sent from Wyoming, R. I., to be tested for arsenic and copper, neither of which was found. Nos. 79-91, inclusive, were analyses of leguminous crops made for the Agricultural Division, the results of which may be found in the report of that Division. Nos. 106-126, inclusive, analyses of sea-weeds reported in Bulletin 21, now being printed.

Swamp Muck.

74 and 75. Sent by E. R. Kenyon, Green Hill, R. I.

	74.	74. When as dry as No. 75.	75
	Per cent.	Per cent.	Per cent.
Water	79.79	33.66	33.66
Nitrogen	0.27	.90	1.18

*These analyses form a series by themselves and are entirely distinct from the fertilizers belonging to the State fertilizer inspection.

Wood Ashes.

76. *Leached* ashes shipped to parties at Wickford Junction. Sampled at the car, October 26, 1892.

77. Sent by Geo. W. Madison, East Greenwich, R. I.

78. Sent by Alfred S. Reynolds, East Greenwich, R. I.

	76.	77.	78.
	Per cent.	Per cent.	Per cent.
Water	35.49	10.19	11.73
Phosphoric acid	1.60	2.34	1.56
Potash (Potassium oxide)	0.91	7.03	7.51
Lime (Calcium oxide)	26.46	....	....
Magnesia (Magnesium oxide)	2.63	....	...

127. Fertilizer, obtained from garbage and refuse of the city of Providence, R. I., treated by the "Simonin process," from the works of I. M. Simonin & Co., Providence, R. I.

Water	5.64	per cent.
Nitrogen	2.81	"
Phosphoric acid	1.63	"
Potash	1.06	"
Lime, (Calcium oxide)	3.56	"
Magnesia (Magnesium oxide)	0.21	"

128. Milk from Kingston, R. I.

Temperature	15° C.
Specific Gravity	1.035
Total Solids	13.43 per cent.
Fat	4.00 " "

129. Mixed fertilizer from Joseph Grimshaw, Woonsocket, R. I.

Water	7.26	per cent.
Nitrogen	5.32	"
Soluble phosphoric acid	trace	
Reverted phosphoric acid	5.25	"

Insoluble phosphoric acid	4.20	per cent.
Total phosphoric acid	9.45	"
Potash	5.68	"
Chlorine	1.20	"

Mr. Grimshaw reports that this fertilizer was purchased of a Woonsocket party and that it was made for him by grinding and mixing together 100 pounds of sulphate of potash and 300 pounds of "tankage" or "animal dust." This fertilizer was bought at the rate of $22.50 per ton, and the commercial value of the sample as analyzed, calculated upon the same basis as employed in the case of the fertilizers collected under the State inspection, is $31.98, or in other words, *the commercial value of the fertilizer exceeds the selling price by $9.48 per ton.* By reference to Bulletin 19, of this Station, page 69, it will be seen that an average of 81 brands of mixed fertilizers sold in this State in 1892, showed the commercial valuation to have been $9.43 *below* the selling price. In this connection one should refer to Bulletin 13, of this Station, page 169, analysis No. 23, showing a "Home Made Fertilizer," and compare that with the mixed fertilizers put on the market for general sale during that year. If these statements and comparisons do not awaken farmers to the great saving to be made by purchasing their own agricultural chemicals and fertilizer stock, then arguments and facts are of no avail! The manufacturer who is bound to succeed, must secure his crude material at as low a price as possible; and the farmer who is awake and looking out for his business as he should, ought to do the same. The rendering establishments and fish works in this State, can supply our farmers with products which can be supplemented by potash, nitrate of soda, etc., to make fertilizers equal to the best sold in the United States, and at a cost decidedly below what they are now paying for the mixed fertilizers which are found upon the market.

ANALYSES OF WATER SENT FOR EXAMINATION.

(Parts per Million.)

Number.	Party Sending, and Locality.	Date of Analysis.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.*	Remarks.
92	Lorenzo Knowles, Wakefield	....	.04	.02	18.00	Fair.
93	Mrs. Anna Perry, Kingston	Nov. 11.	Excessive am't.	Not determined.	58.00	Very dangerous.
94	H. J. Wells. Kingston†	Nov. 11.	.16	.21	4.00	Bad.
95	Rev. J. H. Wells, Kingston	Nov. 12.	.11	.08	29.00	Suspicious.
96	B. L. Hartwell, Kingston	Nov. 12.	.26	.22	28 00	Bad.
97	Wakefield and Narragansett Pier Water Supply‖	Nov.	.03	.45	10.00	Bad.
98	Village Well, Kingston	Nov.	.03	.06	21.00	Fair.
99	T. C. Rodman, Wakefield	Nov. 15.	None.	.01	§20.00	Good.
100	L F. Bell, Wakefield	Nov. 19.	.03	.06	12.00	Good.
101	Lyman Aylesworth, East Greenwich, No. 1	Nov. 9.	.04	.05	13.00	Good.
102	Lyman Aylesworth, East Greenwich, No. 2	Nov. 9.	.13	.05	16.50	Suspicious.
103	From "Bundy" Spring, Wakefield	Nov.	.21	.55	10.00	Dangerous.
104	H. J. Wells, Kingston	Dec. 3.	.05	.08	13.00	Good.
105	R. T. Knowles, Kingston	Dec. 6.	.01	.10	22 00	Suspicious.

* The normal chlorine in uncontaminated wells and springs in this section of the state amounts to from 9 to 13 parts per million. † This sample was a mixture of cistern and well water. § This well is very deep, and the location is such that it is possible that the high chlorine may have been due to a brackish substratum. ‖ Reservoir.

In closing my report, it gives me pleasure to acknowledge my appreciation of the services of my assistant, Mr. B. L. Hartwell, for, to his interest and the careful execution of the work intrusted to him, is due a full share of credit for the work of this Division.

HORTICULTURAL DIVISION.

L. F. KINNEY.

EXPERIMENTS IN THE TREATMENT OF THE POTATO BLIGHT.

The disease known as the "potato blight" appeared last season upon the Station grounds on July 20th. All potato vines were immediately sprayed with the Bordeaux mixture excepting a few rows in each field that were left untreated for comparison. In all cases the treated vines resisted the attack of the disease better than the others. However, the vines of the Early Rose soon began to turn brown and dry up, although it was evident that they were not quite mature. Two other applications of the mixture were made while the vines gave evidence of growth. The increase in yield of large potatoes, due to treatment, was estimated to average about one-fourth of the crop. The early varieties gave the least increase and the late varieties the most.

A field of the Late Beauty of Hebron was treated with the Bordeaux mixture for Mr. Chas. W. Wilcox, of Kingston. The growth of vines was very vigorous, the soil being both fertile and moist. The first application of the mixture was made July 16th, the vines being then in blossom and apparently free from the blight. July 29th a second application of the mixture was made, the vines at the time being generally fresh and green. August 9th, the third and last application of the mixture was made. At this time the untreated check rows gave evidence of the presence

of the blight, and the treated rows were slightly attacked in spots. The disease seemed to spread rapidly over the foliage that had not been treated and in a few days from the above date the vines in the check rows were quite brown and dry while the foliage in the treated rows remained generally green until about the first of September. The effect of this treatment upon the crop of potatoes was very marked, the yield was almost doubled by it and the tubers were much larger and fairer than where no treatment was given.

Another field of Late Beauty of Hebron potatoes was treated for Mr. Oliver Watson, of West Kingston. The field was planted somewhat earlier than Mr. Wilcox's and the soil was not as moist, consequently the vines were more nearly mature about the middle of July when the blight appeared. The first application of the Bordeaux mixture was made July 21st. The vines were then large and even, with scattering blossoms here and there upon them, although the height of the blossoming season had passed. Check rows were left on either side of the field while the main central part was treated. July 30th a second application of the mixture was made and August 6th the third and last treatment was given. The foliage of the check rows was, at this time, almost entirely dead while that of the treated rows was still alive and growing. This condition remained, however, only for about ten days, after which the treated vines gradually became dry and brown. Test plots of these potatoes were dug in my presence September 27th, from which it was determined that the average yield of tubers had been increased 21.7 per cent., or a little more than 48½ bushels per acre, by treating the vines with the Bordeaux mixture. The cost of the treatment was about six dollars per acre.

Material was furnished for the treatment of still another field of potatoes belonging to Mrs. J. G. Clarke of West Kingston. The variety was Early Rose. This field was attacked by the blight several days earlier than either of the others, and it continued to spread gradually over the entire field notwithstanding the fact

that three applications of the Bordeaux mixture were made. This was probably due mainly to the mature condition of the vines at the time they were attacked by the blight. The potatoes were not fully grown at this time but the vines had lost the vigor of their earlier growth. The effect of the treatment of the vines in this case was scarcely appreciable upon the product.

The mixture in all cases was prepared according to the regular formula used at this Station—viz.:

Six pounds of Sulphate of Copper—dissolved in cold water.
Four pounds of Lime slaked in water.

When *cold* the lime-wash was strained through a fine sieve, into the copper solution and water was added to dilute the mixture to 22 gallons.

The applications were made by means of knapsack sprayers in the manner illustrated in the Third Annual Report of this Station, page 149.

EXPERIMENTS WITH REMEDIES FOR THE POTATO "SCAB."

Number 1. The Bordeaux mixture was again used upon seed potatoes at the time of planting as described and illustrated in Bulletin No. 14, page 182. Four rows of Chas. Downing potatoes, each 50 feet long, were used in the experiment; two of which were, and two of which were not, treated. The field had grown potatoes the previous year and stable manure was the only fertilizer applied. The results were as follows:

Treated.	Total.	Scabby.
Yield of large potatoes	62 pounds.	9 per cent.
Yield of small potatoes	55 pounds.	9 per cent.

Not treated.	Total.	Scabby.
Yield of large potatoes	56 pounds.	21 per cent.
Yield of small potatoes	77 pounds.	12 per cent.

The disease was not very prevalent in the field even where the potatoes were not treated, still the results of treatment were more

apparent at the time of harvesting than is indicated by the figures given; for in the untreated rows those potatoes that were attacked by the disease were generally much more disfigured by it than those where treatment had been given.

Number 2. This consisted of a trial of four fungicides as remedies for the potato scab, viz.: The Bordeaux mixture, La Fostite, Powell's Copperdine (Ammoniacal sol. of Carbonate of Copper) and Bichloride of Mercury. Eight rows of potatoes, each 50 feet long, were used in the experiment, four of which received special treatment, the others serving as check rows. The soil and fertilizer were practically the same as in Experiment No. 1.

	Yield.	Scabby.	Yield.	Scabby.
Row A. Seed potatoes sprayed with the Bordeaux mixture in the furrow..................	102 lbs.	22 per cent.		
Row B. Not treated.............			114 lbs.	37 per cent.
Row C. Seed potatoes dusted with La Fostite in furrow.	94 lbs.	26 per cent.		
Row D. Not treated.............			109 lbs.	36 per cent.
Row E. Seed potatoes sprayed with Powell's Copperdine ..	83 lbs.	29 per cent.		
Row G. Not treated.............			92 lbs.	35 per cent.
Row H. Seed potatoes soaked in a weak water solution of Bichloride of mercury* for two hours before planting	94 lbs.	9 per cent.		
Row I. Not treated............			85 lbs	42 per cent.
Total.......	373 lbs.	86 per cent.	400 lbs.	150 per cent.
Average...	93¼ lbs.	21½ per cent.	100 lbs.	37½ per cent.

The treated rows in this experiment yielded less than those that were not treated. This was apparently due to the slightly injurious effects of the fungicides upon the seed potatoes. It was most noticeable in row E where Powell's Copperdine was applied.

* Poison, 1 part Bichloride of Mercury to 1000 of water.

In each case the product from the treated rows was less scabby than the product from the parallel rows that received no special treatment. *The average excess of scab in the untreated rows being 74.4 per cent.* The least scab appeared on the product from Row H, where the seed tubers were soaked in a weak solution of Bichloride of Mercury. Its absence here is quite remarkable because it was supposed that the soil was infested with the disease and in this case only the seed tubers were disinfected.

TRIAL OF LAWN GRASSES.

In the spring of 1890, when the ground about the farm-house was prepared and seeded for a lawn, it was divided into four sections. In the first section Rhode Island Bent (Agrostis Canina) seed was sown, and in the second Kentucky Blue Grass (Poa Pratensis), while the third and fourth sections were duplicates of Nos. 1 and 2, with the exception of the addition, in each case, of white clover seed at the rate of one-half bushel per acre. The space occupied by the lawn contains about 17,000 square feet. The trial has proved an interesting one from the beginning, on account of the constantly changing appearance of the sward in the various sections. The ground was covered first with a green coat in sections 3 and 4 where the clover seed was sown, and during the first summer the clover plants grew vigorously and were conspicuous above the grasses. In section 1, where the clear Rhode Island Bent seed was sown, the finest, thickest and most even sward was formed, although the ground was not covered within two or three weeks as early as in sections 3 and 4. Section 2, where the clear Kentucky Blue Grass seed was sown, was a weedy lawn the first season. The grass plants were not thick at first and they covered the ground slowly. The lawn received several light dressings * of nitrate of soda during the summer, was mowed at regular intervals with a lawn mower and in the fall was very lightly covered with coarse stable fertilizer.

* Nitrate of soda applied at the rate of 75 lbs. per acre.

During the seasons of 1891 and 1892 the lawn has received no special treatment. The clover plants gradually gave up the space occupied by them to the grasses and the plants that remain are so small and inconspicuous that they scarcely need to be mentioned at this time. The relative appearance of sections 1 and 2 has been reversed since the first season. The Kentucky Blue Grass in sections 2 and 4 steadily gained in appearance upon the Rhode Island Bent in sections 1 and 3, so that during the entire summer of 1892 visitors generally pronounced the sward in these sections superior. The Rhode Island Bent turns yellow somewhat earlier in the fall and remains brown in the spring later than the Kentucky Blue Grass. Small bare spots, caused by the Rhode Island Bent plants dying out, are also numerous in sections 1 and 3. From the results of this trial and our observation of the behavior of these grasses in other localities, we are persuaded that the most satisfactory lawn will be formed by sowing a judicious mixture of the seeds of the two kinds, probably about equal parts each, by weight. The addition of the clover seed did not, in this case, improve the sward but on the contrary made too rank a growth during the first two seasons. It was hard to cut smoothly, and of uneven growth when not trimmed frequently.

A REMEDY FOR THE "ROSE BUG," *macrodactyllus subspinosus*, IN THE VINEYARD.

The Rose Bug has been very troublesome in this locality for several years in succession, therefore it was supposed that they would appear in the early part of June last year as usual; and in order to save the fruit buds that were forming in our young vineyard, the vines were thoroughly sprayed during the first week in June with the Bordeaux mixture and Paris green, in the proportion of 50 gallons of the former to 1 pound of the latter. The object of applying the Paris green with the Bordeaux mixture being two-fold, viz., to increase its adhesive properties and to apply a stronger solution than was possible in clear water without

injuring the foliage. Care was exercised to make the application *before the flower buds opened.* If delayed until the vines blossom probably more or less injury would result and the fruit would not "set" perfectly.

The Rose Bugs did appear upon the vines as expected, in great numbers, but the treatment apparently rendered their favorite host-plant very disagreeable to them, so that they came and went without injuring the grape blossoms to any appreciable extent. As a result of this and two other applications of the Bordeaux mixture alone, which were made to prevent the attack of mildew and black rot, the vines that were of sufficient age, each matured several fine clusters of grapes.

In addition to the use of the Bordeaux mixture in the vineyard and potato fields, it has been generally used in the fruit garden and propagating pit, as a fungicide. It has proved especially valuable in checking the ravages of the red rust of the blackberry and the leaf blight of the cherry. It has also been successfully used in preventing the leaf blight of violets.

POULTRY DIVISION.

SAMUEL CUSHMAN.

In our last report we referred to preparations made for a somewhat extensive experiment in the cross breeding of pure bred fowls with a view to the production of the finest market roasters and capons. Twelve varieties of pure bred fowls had been procured and mated for this purpose.

In the selection and mating of these birds we were governed by certain laws, or generally accepted rules, based on the experience of the best stock breeders. As this subject is of great importance to farmers and practical poultry raisers, we feel that we can do no better than to briefly consider it here.

LAWS OF BREEDING.

Poultry breeders, as well as breeders of horses, cattle, sheep, dogs and other domestic animals, have used all available material to develop breeds suited to special purposes. Birds from various parts of the world that have been developed by certain climates, or special conditions, have been selected and bred to retain and strengthen those qualities where ever they are kept. Some breeds of fowls, like the Dorking and several kinds of Games, have been selected and bred for certain purposes, for hundreds of years, and reproduce their qualities with great certainty. Others of later origin have been mated for other qualities and the longer they

are so bred the more their characteristics become fixed and the greater the power of each individual to reproduce like qualities.

Both old and new characters tend to be inherited. Variations occur in all stock. Occasional individuals have very unusual qualities. By repeated selection the variations that occur in a desired direction may be accumulated, and these may be fixed or made hereditary, by breeding only from birds having them in the greatest perfection.

Not only may variations be retained and perpetuated, but modified instincts or acquired characteristics may, to a certain extent, also be transmitted. The effects of habit and surroundings on individuals, or the modification in form, size or other qualities, caused by food, are transmitted. Parts may be developed by use, or from lack of use may remain undeveloped, or become deficient. One organ may be developed at the expense of another. If the influence which produces the changes be continued generation after generation, these conditions are intensified and become hereditary. The tendency to reproduce these acquired developments becomes very strong. There seems to be no apparent limit to the inheritance of acquired characteristics. The instincts of animals, it has been said, are but the inherited experience of past generations.

In and In Breeding.—By mating a cock with his own descendants for several generations, any special qualities in him are firmly established in the progeny, uniformity and prepotency are secured in the shortest time, and the result is a strain having those qualities in a greater degree.

This in and in breeding is desirable only when individuals of extraordinary merit are used. Such may occur among a large number of ordinary merit as the result of variation, and in no other way can those qualities be so surely and quickly held and established. Without in and in breeding any unusual variation occurring only in a single individual would be lost and the influence to reproduce it would be overcome by the opposing influence of

the more fixed qualities in the other stock. If the cock used is unusually vigorous such breeding may for a time increase, instead of lessening the vigor of the stock, but after a number of such matings the stock usually has less constitution.

A pronounced weakness, or an undesirable quality, as well as a desirable quality, may also be increased or intensified, in this way. To regain vigor lost by breeding in and in, and keep the qualities gained, breeders usually introduce new blood by using, for one season, an unrelated female of the same breed. Her progeny is then united with the in-bred stock. The influence of this new blood on the qualities of the strain is mostly overcome by the prepotency acquired by in and in breeding. Any undesirable qualities that may be received are removed by discarding all individuals that show them and by again breeding within the strain for several generations.

Breeders mate birds or animals that are related, in spite of their relationship, because they possess the same desirable qualities; the progeny thus receives a double tendency to develop those qualities. Size and strength is always best secured by using unrelated stock of superior quality.

The oldest pure breeds deteriorate, to a certain extent, without constant selection; and newly formed breeds, without intelligent mating, lose their established characteristics much more quickly. Improved characteristics cannot be retained without the conditions that produced them. Scrub stock may best endure privation. Proper food has much to do with improving or maintaining a breed. Mongrels or fowls mixed indiscriminately, become inferior. Prepotency is lost; there is no strong influence in any particular direction and no uniformity in the quality of the progeny. No dependence can be placed on the results of their breeding.

A flock of birds bred in and in, if the best are each time selected and intelligently combined, will degenerate less quickly than if crossed with a different kind of cock each season. Crossing without method is worse than in and in breeding. By selection a uni-

form breed may be produced from mongrels, while without selection or intelligent combination, the best pure blood soon deteriorates and loses its good qualities.

There are various degrees of pure breeding. Many breeders, whose stock is noted, had at the start several unrelated pens of the highest quality of the same breed. By breeding back and forth between these pens for years, always selecting birds having certain qualities in the greatest degree, they have been able to establish a strain which represents their ideas, and that not only breeds true, but gives a large per cent., of fine birds of their favorite type. Close breeding, combined with rigorous selection, is termed high breeding.

If to such a strain a cockerel of another strain of the same breed were introduced each season, the established special qualities of the strain would be broken up and the results of years of labor would be lost. The introduction of strange blood to such a strain is a very serious thing to the fancier. Although of the same breed, it gives an impulse to reversion and causes the re-appearance of long lost characteristics or faults that have been bred out. When it must be done, a hen should be used, as she has less influence on the blood, and should there be evil results they will be confined to her progeny, instead of extending to the whole flock.

Pure breeds may be used of such quality that the progeny will be below the average even if they are skilfully mated, or the best quality may be so mated that the defects of the parents are increased in the progeny. Even if the best of stock is properly mated, if the progeny is not sufficiently weeded out year after year, if both superior and inferior birds are bred from because they are of pure blood, the result will be degenerate stock. The pick of the flock should be set apart for breeders. Those who build up a reputation for breeding fine stock are the ones who cull most severely. A very small per cent. (rarely more than 25 per cent. of the stock raised) is retained for breeding or for supplying customers with breeding and exhibition birds. The remainder is disposed of as culls.

The importance of rigorous selection cannot be too strongly urged. It is the mainstay of high breeding and should always be practiced. Wild animals and fowls are subjected to severe and unremitting natural selection; those best fitted to re-produce, survive, those deficient in vigor and constitution, do not.

Those who realize the amount of study and money, as well as the years of special care and feeding, that have been expended upon most of the pure breeds, appreciate their worth and do not begrudge the few extra dollars above the price of the common fowl, that are required to procure them. To be sure all birds have not been bred for egg production, or best table qualities; there are many birds that have had time and money spent on them simply to make them beautiful, or to develop some fancy peculiarity, to the detriment of the more valuable practical qualities.

If people wish to cultivate fowls as they do flowers, for the pleasure they receive by so doing, without a thought of profit, it is all right. Those who do not care for such beauty need not cultivate either. For profit they should choose something else. There is such a variety of pure bred fowls—thanks to breeders and fanciers—that the poultry raiser may choose something that will nearly suit his purpose.

Different Characteristics of Breeds.—The poultry raiser has more material to select from than the breeder of cattle, sheep, or hogs. He may choose large or small breeds; stock that is quick to grow or slow to mature; those having legs short or long; fowls scantily feathered or clothed as if for an arctic winter; birds of almost any color; great layers, that are poor table fowl, or those excellent for the table but indifferent layers and slow growers; those that lay a great number of small eggs of poor quality, or others that lay rich, finely flavored eggs, and few of them; hens that lay well in the coldest weather and do poorly in warm, or those that are great layers only during the warmer months.

There are those whose chickens grow their feathers quickly and others whose progeny feather but slowly. There are breeds hav-

ing yellow skin and white skin, white flesh and blue flesh, white fat and yellow fat, and green, black, white or yellow legs. Some have heavy thighs and thin breasts; others have a vast amount of flesh on the breast and other parts of the body. There are birds having large and coarse bones with little flesh, and others with small, fine bones, and very plump bodies.

The chickens of some breeds are little more than skin and bones up to a certain age; some are plump only during a certain stage of immaturity, and others are round and ready for market at any time or age.

There are kinds that although they grow quickly and are plump, are coarse in flesh and not so finely flavored. Some breeds although having the finest table qualities, or the best developed egg producing qualities, are so tender that they are hard to rear, or do not keep in health if kept on clayey or damp land. Others are deficient in some of these qualities but are the hardiest of all breeds. Some bear confinement well, others do not.

There are breeds that do not have the incubating desire while others are noted for their persistency in sitting, and for their docility and ability as mothers. There are fancy and beauty breeds, strict utility breeds and those in which beauty and utility are combined.

Evils of Breeding only for Fancy Points.—In some cases fanciers have taken up a utility and beauty breed and bred it for fancy points only. Such gradually lose their profitable qualities. Birds bred for feather and shape, for exhibition at shows, are subject to so many unnatural conditions that they lose vigor and constitution. They deteriorate in flesh producing qualities or in ability to produce a great number of eggs, and do not, from the practical poultry keeper's point of view, turn the food given them to the best account. Although a fancier's chickens may be so weak constitutionally that few are reared, his object is attained (in some cases) if the desired points are secured in these few.

Mr. Tegetmeier, an English poultry judge and writer, of long

experience, in his new book "Table and Market Poultry, versus Fancy Fowls," says, "I do not hesitate to affirm that no one breed of fowls has been taken in hand by the fancier that has not been seriously depreciated as a useful variety of poultry."

Breeding for the shows, for ornamental or unusual fancy points, he argues, has lessened the value of useful breeds of cattle, sheep, hogs, dogs and poultry, because utility and economic value has not been the object. The modern fancy breeds are useless as compared with old varieties. Fancy stock should not take the place of useful stock.

In Mr. Tegetmeier's opinion "Poultry Shows, as ordinarily conducted, have no more to do with the produce of marketable and useful poultry than Flower Shows have to do with the garden or agricultural produce." He complains of the increasing tendency of poultry shows to encourage mere fancy varieties and to ignore the profitable value of the birds exhibited. He thinks that agricultural societies should do more to encourage exhibition of really useful poultry and less for simply feathered varieties, because ornamental poultry purely is not adapted for the use of the market poultry breeders. Before the "hen fever," upon the advent of cochins, poultry was kept mainly for profit.

He speaks of Plymouth Rocks and Wyandottes as yet unspoiled by English fanciers and as being partly bred to a utility standard. Mr. Tegetmeier refers to fancy breeding as carried on in England and especially in the cities and towns. In this country breeding for show points has not been carried to such extremes. There are here more fowls in the hands of fanciers who breed for utility as well as for beauty, and more varieties yet unspoiled. We think, however, Mr. Tegetmeier's presentation of the case makes plain the true reason for *the prejudice so general among farmers and market poultry raisers in this country against pure bred poultry.* But one should make some distinction between strictly fancy birds and those bred for utility.

Value of Beauty and Standard Points.—The great benefit that

fanciers have been to the poultry industry generally is not sufficiently understood or appreciated. Mr. Lewis Wright, a prominent English writer, says in the Illustrated Poultry Book, "Without the fancy points, the fancier would never spend the time, thought, and money that he does to maintain those breeds which without him would be lost and the loss of which would be irreparable." Years of careful study, selection and special breeding are given to a breed. It is then shown and advertised about the country. The visitor to the poultry show is tempted to keep fowls on account of their beauty rather than their utility. Beautiful productions bring high prices and that which is highly valued receives good care. Birds bought for beauty are widely scattered and in the hands of the majority are then bred for utility.

The Indian Games have for the past few years had a great run in this country. While they were in the hands of a few they were advertised extensively and their virtues well written up for the poultry press. As a result they were in great demand, at high prices, and they have been scattered all over the country. The best birds of England were imported and large sums were spent by many breeders to secure the best. Doubtless many fanciers have made considerable money out of them but probably the country at large receives the greater benefit. These birds have extraordinary flesh development, a small amount of offal and yellow skin and legs. By their use some of the best cross-bred fowls for the table may be produced. As soon as they become more plentiful they may be procured by farmers and market poultry raisers at a little above the price of common fowls, and the table qualities of the poultry of the country will doubtless thus be improved.

None but fanciers would perfect such a breed or so quickly introduce it to all parts of the country. One having simply a utility breed has no such motive to make it known. He could get no customers at paying prices. It is a notorious fact that those who raise stock for profit only, are almost invariably extremely

reluctant to pay more for a stock bird than he is worth in the market. The value of a pure bred male in the production of beef, mutton or pork, is more generally appreciated.

Fanciers are a Benefit.—Wherever Poultry Exhibitions have been held there has usually been a great improvement in the size and quality of the poultry of the surrounding country. A fixed standard for a breed is very important. Without one those differing in opinion would breed to different standards and every time the stock changed hands it would be bred to suit the ideas of the individual. Uniformity and hereditary characteristics or tendencies would thus be weakened or entirely lost.

Without a doubt great good has been accomplished by fanciers. They have increased the number of those who keep fowl, have spread a knowledge of proper care and multiplied the desirable breeds. They also keep up the breeds that are the foundation of the market poultry raisers' success. Poultry raisers run out the breeds; the fancier prevents them from becoming extinct. Mr. Lewis Wright says on this subject, "almost every breed has some special value for the sake of which it could ill be spared, and even when comparatively of little value in itself, is often highly useful as a cross." Fanciers take more pains to secure, at any cost, the best breeding stock and many of their "culls," or discarded birds, possess the best utility points of the breed, and are valuable material for the farmer. From them comes the raw material for all real improvement in market poultry.

Value of Poultry Exhibitions to the State.—The foregoing we believe explains the true relation of the fanciers to the practical poultry raisers. The former have, without doubt, in this State, been of great benefit to the latter. Their exhibitions have in the past educated the public as to the merits of well bred stock. The opportunity thus afforded the market poultrymen and farmers (as well as intending fanciers) to study and compare the different breeds together, is of great value. For this reason Poultry, as well as Agricultural and Horticultural Exhibitions, deserve public

and State aid. Their usefulness would no doubt be much increased if more encouragement were given to "utility" exhibits. An extensive exhibit by market poultry raisers would increase the value of the "Shows," and appeal more strongly to practical men, who would then realize more fully the part pure breeds play in the production of poultry for profit.

If liberal prizes were offered for cross bred fowls, geese, ducks and turkeys for the table, to be shown both alive and dressed, for dressed pure breeds, collections of eggs of the different varieties, and for best capons, both alive and dressed, the exhibitions would be of more general interest. By requiring labels giving sex, age, and breed of birds, how they were crossed, and their live and dressed weights, such an exhibit could be made instructive to all.

Quality and quantity of flesh, greatest bulk in most valuable parts, absence of waste or offal, and smallness of bone, in table poultry, receives too little consideration in this country. In France table poultry is produced in greater perfection than in any other country and its fattening is also best understood. Exhibitions of dressed poultry have been held there annually for years, and at a show in Paris $800.00 was offered in prizes for dressed poultry, and two thousand carcasses were exhibited. French breeders pay little attention to beauty or color of feather.

Birds of the finest quality bring the very highest price where they are appreciated. Exhibitions of this sort educate the buyers of table poultry and create a demand for high quality.

If the best breeds have lost in economic value by being bred for show points, the farmer and market raiser may restore the original good qualities. This can be done by selecting stock for their useful points and breeding, for several seasons, for utility only, but these qualities can be immediately recovered by making first crosses.

Cross Breeding.--Breeders of cattle, poultry and other stock, find that by crossing pure breeds greater vigor is secured in the progeny. The union of two varieties, equal in hardiness, gives

stock that is more hardy than the parents. An improvement in this respect can be depended upon.

By such a combination of different elements or tendencies an impulse is also given that usually causes them to grow quicker and larger and to be more prolific. By intelligent selection of the breeds the desirable qualities of two may be combined in the cross. Defects in one may be counterbalanced by the influence of another and most or all of the best qualities retained.

Stock may be produced that will excel either pure bred parent in profitable qualities. Fowls that cannot stand exposure but that are great layers, if crossed with certain breeds that are noted for hardiness and are good layers, will give birds that are quite hardy and also great layers. The influence of the hardy breed to lessen egg production is counterbalanced by the greater vigor given by it, which also sustains egg production in the cross.

Fowls that are noted for table qualities but are too tender to be reared successfully, may be used to produce crosses that are hardy and vigorous, and in quality of flesh and appearance none the less desirable for the table. A pure breed noted for a certain profitable quality may be so mated with another pure breed that the first cross progeny will excel either of them in that particular quality. Combinations almost without number may thus be made.

First Crosses Most Valuable.—For the reasons given the best results are obtained from a first cross. These birds are so fine that there is a great temptation to breed from them, but they possess little power to reproduce their like. "A good animal is a good animal however it may come but pedigree alone insures succession." Mixtures take back to remote ancestors. Cross bred birds, if bred from at all, should be mated to pure breeds. In this way three or four breeds may be combined, but this practice is not recommended as most profitable and only where size and hardiness are the only objects.

The improvement secured by crossing pure bred males on common stock is due to the higher breeding of the males, or the power

of inherited tendencies. A flock may be graded up; made almost a pure breed, by using only pure bred cocks of a certain breed for several generations. The worse bred the females, or the more mixed they are, the greater will be the influence of a well bred male on the offspring. Grading with one breed is better than first crossing with different breeds if the progeny is to be retained and bred from. The first cross will be most thrifty and profitable unless the original flock is very inferior. The purer the breeds used, and the longer they have been established, the more certain will be the results of a cross. High grades, in which the influence of a breed is established, are nearly equal to the pure breed, for the production of first crosses. They cost less but several seasons' breeding is required to produce them. The best plan is to use the pure breeds each season for raising the cross bred stock. The latter if not bred from at all may be forced or stimulated to any extent that is profitable and no injury will be done to future generations. The usefulness of some of the most popular new breeds is partly due to their having been recently made by crossing.

Cross breeding is the opposite of pure breeding and in and in breeding and is governed by different laws. In pure breeding, birds having the same inherited excellencies in the highest degree, are bred together, although they may be mated so as to combine a minor deficiency in one bird with pronounced excellencies in the same point in the others. In first crossing we combine two breeds having constitutionally different tendencies, i. e., those that present strong contrasts to each other. Some breeds unite well, others do not. Unless good qualities are blended and held, the only gain is an increase in hardiness. If when crossing a better system of feeding is adopted, much greater improvement is made.

The Selection and Mating of Breeding Stock.—The selection of the finest individuals of a breed is of as much, or of more importance, than the choice of a breed. Pure breeds have as strong an impulse to perpetuate their inferior characteristics as their supe-

rior qualities. Breed only from the best males that can be procured. Avoid those showing the slightest trace of sickness or the effects of disease. Disease, or a tendency to disease, is transmitted. Weakness re-produces weakness, and vigor begets vigor. Hereditary unsoundness or a pre-disposition to disease, may be made the dominant characteristic of a strain. The offspring of stock that is very young or immature, or imperfectly developed, or that is constitutionally impaired by privation or neglect, will inherit a condition of the system that readily becomes diseased from slight exciting causes. Hardiness, vitality and vigor of constitution are of more importance in poultry for profit than all other qualities combined. Only the most vigorous should be bred from.

Birds having a strong, bright eye, that are cheerful and active, and are not much above the average of the breed in size, are the most desirable. A dull and sunken eye shows defective nutritive power and lack of constitution and vigor. The progeny of two year old fowls grow larger, mature earlier, and feather more rapidly, than that from younger stock. A cockerel mated to mature hens usually gives large and vigorous chickens. If the hens are few in number there is generally a preponderance of cockerels, especially from the earliest eggs. Cockerels are generally more efficient early in the season than cocks. If pullets are to be bred from they should be mated to a mature cock. The earlier eggs will produce more cockerels than the later ones. As a rule, other things being equal, the fewer the number of hens allowed to a male the greater the number of cockerels produced, and the greater the number of hens allowed, the greater the proportion of pullets produced. The number of hens that should be allowed to a male will vary with the breed, the age, and whether they are at full liberty or closely confined. They should be mated early and remain together during the season. Pullets' eggs are smaller than hens' eggs and the chickens obtained are also smaller

and not so strong. Size in progeny is usually most influenced by the hen.*

Theory versus Practice.—To test in a measure this knowledge, and that additional light might be gained, as to the most desirable cross matings for the production of table poultry, a number of experiments were undertaken. Many have written on this subject but it is hard to distinguish between that which is the result of actual experience and that which is simply theory worked out at the writer's desk. While the latter is of value to the experimenter —assists him to decide which cross matings he will test—no extensive poultry keeper can safely follow advice based on theory only. Some breeds combine well, while others, apparently just as well suited for crossing, owing to some influence that is difficult to account for, do not give good results.

Fowls, as well as animals, have beside those qualities which are developed and readily seen, many others, also inherited from ancestors, which remain latent and do not show. These inherited tendencies which have been latent or suppressed for a long time, may be made active by crossing, or by certain combinations of blood in pure breeding. This cropping out of old ancestral qualities is termed "breeding back," "throwing back," and "reversion."

Inheritance may be strong in a pure breed but its prepotency weak, when it is crossed with another breed. Again, prepotency may be strong in one sex of a breed and weak in the other. There are so many invisible tendencies and forces that the results of a cross can not be foretold with any certainty. The types of some breeds are obliterated or absorbed by crossing. Some characteristics are never blended by crossing but are transferred in an unmodified state from either parent. By crossing, characteristics

* In preparing the foregoing we have appropriated ideas wherever we have found them, and would give credit to the following publications as the source of many of them. Darwin's "Plants and Animals under Domestication"; Miles' "Stock Breeding"; Wright's "Illustrated Book of Poultry"; Tegetmeier's "Poultry for the Table and Market, versus Fancy Fowls." Articles by Mason C. Weld.

may be obliterated, breeds modified, degenerated, or new breeds formed.

Different stock will be required to raise, with hens in mid-winter, chickens that are sold as roasters when weighing 4 to 6 lbs. each, than is necessary when broilers are reared, by artificial means, that are marketed when they weigh 1½ to 2 lbs. each. For the production of capons, stock that is hardy enough to grow in winter, that does not develop sexually until nearly full grown and that will make the largest and heaviest fowl possible, is the most desirable.

In many markets in this country dressed fowls having yellow legs and skin are preferred to those having black, blue or white legs and white flesh, even though the latter are more plump, tender and juicy. In England and France yellow skin and legs are looked upon with disfavor, as indicating coarseness, a lack of flavor, and of the finest qualities. Of late years in New York and Philadelphia markets there is no distinction made in this respect where the poultry is of high quality. In the east, as a rule, the ordinary market stock sells best if yellow. As long as this prejudice exists the average raiser will find it best to comply with the demand and be particular to furnish yellow poultry, but the producer of the highest quality of dressed poultry, or one who sells direct to customers, need not on account of this be restrained from using some of the finest material for market purposes.

Qualities Desired in a Table Fowl. — Hardiness is, without doubt, of the first importance in poultry raised for the table, that there may be but slight loss. Quick growth and early maturity, good feeding qualities and disposition to readily take on fat, or the ability to return the largest profit for food consumed, are also indispensable to profitable production, while a good quality of flesh that is tender and juicy with the largest amount on breast, back and wings, as well as fine bones and least amount of offal, gives the finest carcass. Excessive length of leg or neck, prominent joints, angular projections of the frame, as well as a large

amount of offal, are undesirable. A nervous disposition is also not desirable. Breeds with small combs usually make the best table fowl and are more readily fattened.

There are no breeds more hardy than Cochins and Brahmas. Cochin chickens can be raised when all other breeds would perish. None are so free from colds or croup, or better able to thrive under close confinement, or in cold weather. They are also great feeders and fatten readily. Their defects are thin breasts, large legs, coarse bones, and angular frames.

For quick growers, Houdans, Creve-cœurs, Wyandottes and Plymouth Rocks, are good material and the two latter are fairly hardy, and are of a broad and blocky build. Plymouth Rocks have rather coarse flesh and also dark pin feathers, if dressed when young.

For heavy flesh development the Dorking with its wide build and rectangular form, or outline, is noted, as well as the solid fleshed Games and especially the extraordinarily developed Indian Game. Houdans are also very plump having considerable flesh on the back as well as on the breast and small bones. Games are, however, slower growers, and none of these birds are as hardy as could be desired, the Dorking especially being very tender and very hard to rear. Indian Games have long necks and legs, are too closely and thinly feathered to withstand cold, and are liable to disease. It seems that the most desirable flesh development and greatest hardiness are not found combined in one breed.

EXPERIMENTS IN CROSSING PURE BRED FOWLS.

For the first season's experiment in crossing, twelve varieties of pure bred fowls were procured. Although not exhibition birds they were typical fowls of their kind and from prize winning strains. They were selected for their vigor and good condition rather than for their fancy points, and most of them were secured at a moderate price. With them, sixteen combinations were attempted and the yards were made up as follows:

Indian Game Cockerel	Light Brahma hens. Houdan hens.
Indian Game Cockerel	Golden Wyandotte hens. Buff Cochin hens.
White Wyandotte Cockerel	Light Brahma hens. Indian Game hens.
Buff Cochin Cock	Light Brama pullets. Plymouth Rock pullets.
Houdan Cockerel	Partridge Cochin hens.
Silver Gray Dorking Cock	Indian Game pullets. Dark Brahma pullets.
Houdan Cock	Indian Game hens. Light Brahma hens.
Silver Duckwing Game Cockerel.	Dark Brahma hens. Silver Gray Dorking hens.
Plymouth Rock Cockerel	Buff Cochin hens.
Dark Brahma Cockerel	Silver Wyandotte hens. Indian Game and Partridge. Cochin first cross pullet.
Late in the season Indian Game Cockerel	Plymouth Rock pullets.

Most of the yards contained two varieties of hens or pullets but those were put together that produced eggs of a different size and color, therefore the eggs were easily distinguished. The stock was bought from different parties and birds two years old were chosen in preference to those that were younger. As they had been raised and cared for differently, and were of different ages, as well as differently housed, no attempt was made to compare their egg yields. They were rather restricted for house and yard room. They were fed a well scalded mess of corn meal, bran, and beef scraps in the morning, oats or cracked barley at noon, and corn at night. A large number of eggs were received from them

but the per cent. of fertility was very low, while in many that were fertile the germ seemed weak and did not mature. But little fresh meat, or ground raw bone, or green food, was fed.

The Houdan cock was three years old and was found to be worthless. He was fairly plump and heavy but the eggs from this yard did not hatch. But one or two chickens were raised from the Houdan cockerel, as he died early in the season. None of the Houdan hens were lost. They were bright and active, seemed fairly hardy, and laid a good number of white eggs.

The Dorkings were bright and cheerful but lacked vigor, and were sensitive to cold and damp. They were badly reduced at moulting time, and several had "bumble foot," an affection to which they seem to be predisposed.

The Indian Game cockerels were tender and subject to colds while immature, but seemed quite strong and vigorous, later. A lot of cockerels bought of Sharp, of New York State, had the foulest kind of roup when received. Part were killed and the others were cured after a long course of treatment but they were continually getting out of condition and the mortality among their chickens was large. It would have been better to have killed them all when received. Other stock bought from two different parties was as fine as we have seen. The pure Indian Games, however, showed a constitutional tendency to canker, eruptions about the head, and colds. They were on the whole more subject to disease than many of the other pure breeds. This experience I find agrees with that of many others who have bred them for a considerable time.

The Buff Cochins were hardy and healthy at all times, and laid a surprisingly large number of eggs in the very coldest weather.

The Plymouth Rock pullets laid a large number of rather small eggs but moulted badly, and several died the latter part of the summer. Our Golden Wyandotte and Silver Wyandotte hens and White Wyandotte cockerel were thrifty, and appeared to be next to the Brahmas and Cochins in hardiness. They were apparently

more hardy than the Plymouth Rocks, though the latter were yearlings. Silver Wyandottes laid the largest eggs of all, as well as a good number.

The Dark Brahmas were less hardy than the light variety; the latter kept in the best condition under the same care. These impressions in regard to the breeds should not be given too much weight, as the birds probably did not have an equal chance before we procured them, and some are more unfavorably affected by confinement, and besides there is a great difference in the various strains or families of the same breed.

Eggs were set under hens and in incubators but the results were the same in each case. Others we found were also getting but a small per cent. of chickens from the eggs set. A great variation was noticed in the strength and hardiness of the chickens of the various crosses.

From some yards no eggs were hatched, from others no chickens were raised to maturity. While a number of chickens of the Dorking and Indian Game cross were hatched, none were reared to maturity. Of all the crosses the chickens from the Indian Game and Light Brahma, and Indian Game and Buff Cochin, seemed to do the best. Those from the White Wyandotte and Indian Game came next; they were lumps of flesh at all times, and quick growers. The Indian Game and Golden Wyandotte cross were next in thrift. The Plymouth Rock and Buff Cochin combination was less thrifty and seemed undesirable, while the Dark Brahma and Silver Wyandotte cross gave the least desirable results.

DESCRIPTION OF CROSSES.

Indian Game and Light Brahma.—Cockerel, plumage similar to Light Brahma but darker, with some yellow. Larger than Brahma and between the two in shape, comb and wattles the same as Brahma. Body wide, legs, long.

Pullet, plumage brown with penciled feathers, dark hackles. Resemble Brown Malay hen except in the slight leg feathering.

Lay well, eggs as large as Brahmas. Each sex is as uniform in size and in color as a pure breed. They are hardy, quiet, good feeders, and are closely feathered. There was hardly any loss among the chickens. A very desirable cross.

Indian Game and Houdan.—Plumage black, or slightly mixed with white, small crests. Cockerels have flesh colored legs and pullets dark legs. Are active, grow quick, and fairly hardy. There is not much difference in size between cockerels and pullets. Are uniform in appearance.

Indian Game and Golden Wyandotte.—In plumage and appearance most like Golden Wyandotte. Markings, uniform. Fairly hardy, quick, active, and plump at any age. Disposition, rather excitable. Cockerels much larger than pullets. But slight loss among chickens.

Indian Game and Buff Cochin.—None but pullets reared. Similar in plumage and appearance to Light Brahma cross. Not so closely feathered, legs shorter and more feathers on them. Larger and brighter comb.

White Wyandotte and Light Brahma.—In appearance between the two. Both rose and single combs appear. Body more stocky than Brahma, legs shorter, plumage, faded and muddy. Show more red in comb and face than Brahmas. Disposition, quiet; good feeders and hardy. Cockerels grow very large.

White Wyandotte and Indian Game.—Plumage similar to Silver Wyandotte, dark with gray neck; breast feathers in pullets slightly spangled with white; legs and neck short; rose comb. Grow quickly, and are always plump and hardy. Pullets are excellent layers. Cockerels not much larger than the pullets. A desirable cross.

Houdan and Partridge Cochin.—Plumage, a mixture of the two. Small crests; legs, both light and dark, and feathered; active, quick growers.

Silver Gray Dorking and Dark Brahma.—*Cockerel*, plumage,

similar; larger pea comb; legs, short and feathered; long body; hardy. *Pullet*, large, Dorking shape and plumage; feathered legs; single comb. Very bright and thrifty. Good layers. Uniform in size and plumage, and handsome. An excellent cross for both utility and beauty.

Silver Duckwing Game and Dorking.—Plumage, the same and very handsome. Single comb and willow legs. Body, plump. Pullets great layers of small, white eggs. Good for table but best for eggs.

Plymouth Rock and Buff Cochin.—Plymouth Rock plumage occasionally with some buff feathers. Tall and gaunt; single combs. Were not thrifty.

Indian Game and Plymouth Rock.—Cockerel between Indian Game and Plymouth Rock in shape. Comb, like Indian Game; plumage, like Plymouth Rock; body, plump and solid. Pullets all black and more like Indian Game in shape. Shanks dark, feet yellow. Considerable loss among chickens. Others make the same complaint. In our case it might have been due to the poor condition of the cock, which was one of those mentioned as having been out of condition.

Silver Wyandottes are said to have received in their make-up some Dark Brahma blood. This may account for the unsatisfactory results gained by crossing these hens with the Dark Brahma Cockerel. The cockerels from the Indian Game Cock and Light Brahma hens, most resembled the Light Brahmas, while the pullets were most like the Indian Games. In this cross the female parent has more influence on the size. Cockerels from the Indian Game Cockerel and Plymouth Rock hens, had the Plymouth Rock plumage, while the pullets were black.

This cross bred stock was exhibited at the Kingston Fair, at the State Fair, and at the Exhibition of the Rhode Island Poultry Society, at the Pawtucket Skating Rink. Placards, giving the matings which produced the cross, were placed on the coops of

each kind, and at the last named exhibition dressed specimens were also shown. The latter were hung up in a row on hooks, each carcass bearing a tag giving the cross, the sex, and the weight both alive and dressed. The poultry keeper could thus compare the live birds with those that were dressed, as well as compare the difference in the amount of shrinkage between the different crosses when prepared for market.

The Poultry Exhibition was held the last week in December. Most of the stock was sufficiently matured to have passed the tender stage and market men would have classed it as fowl. In the following table is given both the live and dressed weights, actual shrinkage and per cent. of shrinkage, of the different specimens of dressed poultry that were exhibited. As there was a difference in the age of some of the crosses their weights can not be justly compared in judging of their growth, as could have been done if all had been of one age and dressed when most marketable.

It will be noticed that the proportion of shrinkage was the least in some of the capons and light in the slips. The old capon, weighing 11 lbs., 8 oz., lost 7 per cent; the young capon, White Wyandotte and Indian Game cross, weighing 8 lbs., 7 oz., lost 8 per cent.; the Dorking and Dark Brahma young capon, weighing 7 lbs., 11 oz., lost 16 per cent.; the Plymouth Rock and Buff Cochin slip, weighing 8 lbs., 15 oz., lost 13 per cent., and the Silver Duckwing Game and Dorking slip, weighing 5 lbs., 9 oz., lost 16 per cent.

The heaviest cockerels were Indian Game and Golden Wyandotte, 8 lbs., 3 oz.; Indian Game and Light Brahma, 8 lbs., 2 oz.; Dorking and Dark Brahma, 8 lbs., 2 oz., and White Wyandotte and Light Brahma, 8 lbs., 1 oz., there being only a difference of a couple of ounces in their weights. The White Wyandotte and Light Brahma shrunk 13 per cent.; the Indian Game and Golden Wyandotte 14 per cent.; the Dorking and Dark Brahma 18 per cent, and the Indian Game and Light Brahma 19 per cent.

Of the pullets the Indian Game and Light Brahma cross, weigh-

ing 6 lbs., 9 oz., lost in dressing 11 per cent., and the White Wyandotte and Light Brahma, weighing 6 lbs., 11 oz., lost 15 per cent. All of the above mentioned birds were in fine condition when dressed, and, with the exception of the old capon, were so nearly alike in age that they may be justly compared.

Parentage.		Sex of Cross.	Live Weight.	Dressed. Weight.	Actual Shrinkage.	Per Cent. of Shrinkage.
Male.	Female.					
Indian Game	Light Brahma	Cockerel	8 lbs. 2 oz.	6 lbs. 9 oz.	1 lb. 9 oz.	19 per cent.
Indian Game	Light Brahma	Cockerel	7 lbs. 8 oz.	6 lbs. 7 oz.	1 lb. 1 oz.	14 " "
Indian Game	Light Brahma	Pullet	6 lbs. 9 oz.	5 lbs. 12 oz.	0 lb. 13 oz	11 " "
Indian Game	Houdan	Cockerel	6 lbs. 12 oz.	6 lbs. 0 oz.	0 lb. 12 oz.	11 " "
Indian Game	Houdan	Pullet	5 lbs. 1 oz.	4 lbs. 0 oz.	1 lb. 1 oz.	21 " "
Indian Game	G. Wyandotte	Cockerel	8 lbs. 3 oz.	7 lbs. 1 oz.	1 lb. 2 oz.	14 " "
Indian Game	G. Wyandotte	Cockerel	7 lbs. 12 oz.	6 lbs. 11 oz.	1 lb. 1 oz.	14 " "
Indian Game	G. Wyandotte	Pullet	4 lbs. 3 oz.	3 lbs. 8 oz.	0 lb. 11 oz.	16 " "
White Wyandotte	Light Brahma	Cockerel	8 lbs. 1 oz.	7 lbs. 0 oz.	1 lb. 1 oz.	13 " "
White Wyandotte	Light Brahma	Cockerel	7 lbs. 18 oz.	6 lbs. 1 oz.	1 lb. 7 oz.	19 " "
White Wyandotte	Light Brahma	Pullet	6 lbs. 11 oz.	5 lbs. 11 oz.	1 lb. 0 oz.	15 " "
White Wyandotte	Indian Game	Cockerel	6 lbs. 8 oz.	5 lbs. 6 oz.	1 lb. 2 oz.	17 " "
White Wyandotte	Indian Game	Cockerel	6 lbs. 0 oz.	5 lbs. 1 oz.	0 lb. 15 oz.	16 " "
White Wyandotte	Indian Game	Pullet	5 lbs. 3 oz.	4 lbs. 9 oz.	0 lb. 10 oz.	12 " "
White Wyandotte	Indian Game	Young Capon	8 lbs. 7 oz.	7 lbs. 12 oz.	0 lb. 11 oz.	8 " "
Houdan	Partridge Cochin	Cockerel	6 lbs. 6 oz.	5 lbs. 0 oz.	1 lb. 6 oz.	22 " "
Houdan	Partridge Cochin	Pullet	5 lbs. 3 oz.	4 lbs. 4 oz.	0 lb. 15 oz.	18 " "
S. G. Dorking	Dark Brahma	Cockerel	8 lbs. 2 oz.	6 lbs. 11 oz.	1 lb. 7 oz.	18 " "
S. G. Dorking	Dark Brahma	Young Capon	7 lbs. 11 oz.	6 lbs. 7 oz.	1 lb. 4 oz.	16 " "
S. D. Game	S. G. Dorking	Cockerel	6 lbs. 12 oz.	5 lbs. 7 oz.	1 lb. 5 oz.	19 " "
S. D. Game	S. G. Dorking	Slip	5 lbs. 9 oz.	4 lbs. 11 oz.	0 lb. 14 oz.	16 " "
S. D. Game	S. G. Dorking	Pullet	4 lbs. 13 oz.	3 lbs. 11 oz	1 lb. 2 oz.	23 " "
Plymouth Rock	Black Cochin	Cockerel	7 lbs. 12 oz.	6 lbs. 5 oz.	1 lb. 7 oz.	19 " "
Plymouth Rock	Black Cochin	Slip	8 lbs. 15 oz.	7 lbs. 12 oz.	1 lb. 3 oz.	13 " "
Dark Brahma	Partridge Cochin	Capon, 21 months old	11 lbs. 8 oz.	10 lbs. 12 oz.	0 lb. 12 oz.	7 " "

DESCRIPTION OF CARCASSES.

Indian Game and Light Brahma. Cockerel.—Full breast and heavy thighs; very yellow shanks. Flesh, light colored; skin, fine and yellow; fat, evenly distributed. Legs and neck too long.

Pullet.—Very round bodied and very plump in breast and rump. Fat, evenly distributed; skin, fine and yellow; flesh, light colored. Finest carcass of all.

Indian Game and Houdan. Cockerel.—Plump breast, good thighs and rump; white skin and bluish flesh. Considerable flesh on back. Fat, white and even; legs, flesh colored and with fifth toe.

Pullet.—Legs, dark; fat, yellow; skin, fine grained and tender; flesh, bluish like a turkey.

Indian Game and Golden Wyandotte. Cockerel.—Breast and thighs fairly plump; rump, full; legs and skin, yellow; fat, yellow; dark pin feathers. Rather long in leg.

Pullet.—Much smaller in size than cockerel. Breast and thighs plump and of good color; skin, very yellow; fat, yellow; shanks, dark and feet yellow.

Indian Game and Buff Cochin. Pullet.—Breast and thighs plump; fat, very yellow and unevenly distributed; skin, rather coarse and very yellow; shanks very yellow.

White Wyandotte and Light Brahma. Cockerel.—More angular than the others. Less flesh on breast and body; flesh, good color; skin, fine and good color; shanks, yellow; fat, uneven.

Pullet.—Not so wide in breast or full in flesh as some others. Flesh, fine grained, of good color; shanks, yellow; fat, uneven; skin, light yellow, very fine grained and handsome. A fine carcass, evidently second or third best.

White Wyandotte and Indian Game. Cockerel.—Body smaller and narrower than Indian Game and Light Brahma cross but not

so leggy. Rump, plump; flesh, light colored; skin, of a fine yellow but coarse in places; legs and fat very yellow.

Pullet.—Smaller. Breast very plump and round, but not so wide. Less rump; skin, fine, tender and yellow; fat, yellow. Probably second best pullet.

Silver Gray Dorking and Dark Brahma.—Flesh, full, white or pink, soft and tender; skin, fine and pearly white; fat, light colored; breast, long.

Silver Duckwing Game and Dorking. Cockerel.—Solid body; flesh, bluish; legs, flesh colored. *Pullet.* Breast, plump and tender; fat, light yellow and evenly distributed; flesh, bluish; skin, fine; legs, willow.

Plymouth Rock and Buff Cochin.—Rather sharp in breast; not so yellow; skin, coarse; pin feathers show; legs, fine yellow.

Houdan and Partridge Cochin.—Plump bodied and tender; flesh, bluish; legs, light and black.

The opinion of poultry judges, veteran breeders and market-men was sought as to the relative value of the different crosses for table purposes, as shown by these specimens. They unanimously pronounced the Indian Game and Light Brahma cross pullet the finest carcass. The finest cockerel was also of this cross. The White Wyandotte and Indian Game pullet was pronounced second best by most and the White Wyandotte and Light Brahma pullet about as fine. An Indian Game and Golden Wyandotte cockerel was considered second best cockerel and the Dorking and Dark Brahma third.

The judging was in accordance with the popular demand for yellow poultry. If these birds had been cooked alike, brought to the table and tested by the same parties for the finest flavor and the tenderest and most juicy flesh, the verdict might or might not have been in favor of the white or black legged, and white or blue fleshed specimens of the Dorking or Houdan crosses.

Judging from these experiments, the raiser of market poultry

will not make a mistake if he crosses Indian Game cockerels or cocks on Light Brahma hens, or on any variety of Wyandotte hens; or Wyandotte males on Indian Game hens or Light Brahma hens. It was found that Indian Games and their crosses were harder to pluck and more difficult to caponize than any other of the crosses.

As half the stock reared on an egg farm will be cockerels, which should be marketed at the roaster age, and as the hens (according to the best authorities) should also, to get the most profitable results, be marketed after their first season's laying and before they commence to moult, it will be seen that marketable qualities as well as hardiness may not be even secondary to the greatest egg producing qualities, in stock kept for egg production.

These experiments in cross breeding will be continued. Some of last season's matings will be repeated and the same varieties mated in a reversed order; a few cross breds will also be mated to different pure breeds to unite three breeds. The results will be published from time to time.

In addition to the buildings described in the Fourth Annual Report, pages 90 to 93, there have been erected during the past year a house for brooding young chickens and a turkey shed. The latter is similar to a carriage shed, with slatted front and is 20 feet long by 12 wide. Early in the spring a few turkeys were procured from one of the largest Rhode Island turkey raisers, also a wild gobbler from Maryland, in hopes that there might be raised, and introduced about the State, hardy, half wild turkeys for breeding. A number of visits were made to extensive turkey raisers, successful and unsuccessful, to learn their methods of management.

The brooder house, referred to, is 40 feet long by 15 wide and runs east and west. It has a double pitch roof, is 6 feet high at the back, 7 feet at the ridge (which is 3 feet from the back) and 4 feet high in front. It is covered, both roof and sides, with "Neponsett" paper and is painted. Inside, along the back of the

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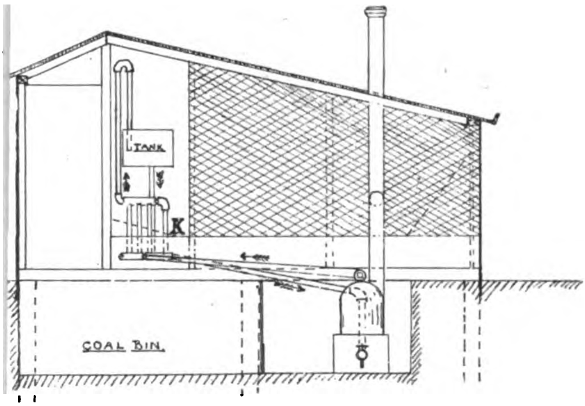

INTERIOR END VIEW.

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house is a 3-foot passageway with a door opening out at each end. The brooders run the length of the building alongside this passageway and are heated by hot water pipes from a No. 2 "Thayer Hot Water Heater." This is located at the west end, in a 4 by 5 pit that is 3 feet deep, and is connected with a cement chimney. This size of heater has a capacity much greater than is required to heat this house, and, it is thought, will be sufficient should it be extended 50 feet, or if a double brooder house, 25 feet long running north and south, should be connected with it.

The flow pipes consist of two one-inch pipes connected by headers and run the whole length of the building within the brooders. The return pipes are the same in size and number and both run side by side, the return being in front. There is a slight pitch to the pipes, the end farthest from the heater being higher, about 5 inches rise in the 35 feet.

At this end, farthest from the heater, they extend upright and project above the brooders about 18 inches where the flow is connected to the return by a header. From this highest point in the circulation, a vent pipe for the escape of steam, rises and turns down into the water tank just above. A feed pipe, in which there is a check valve to prevent water backing up, runs from the bottom of the water tank and connects with the return pipe at its lowest point at this end of the building.

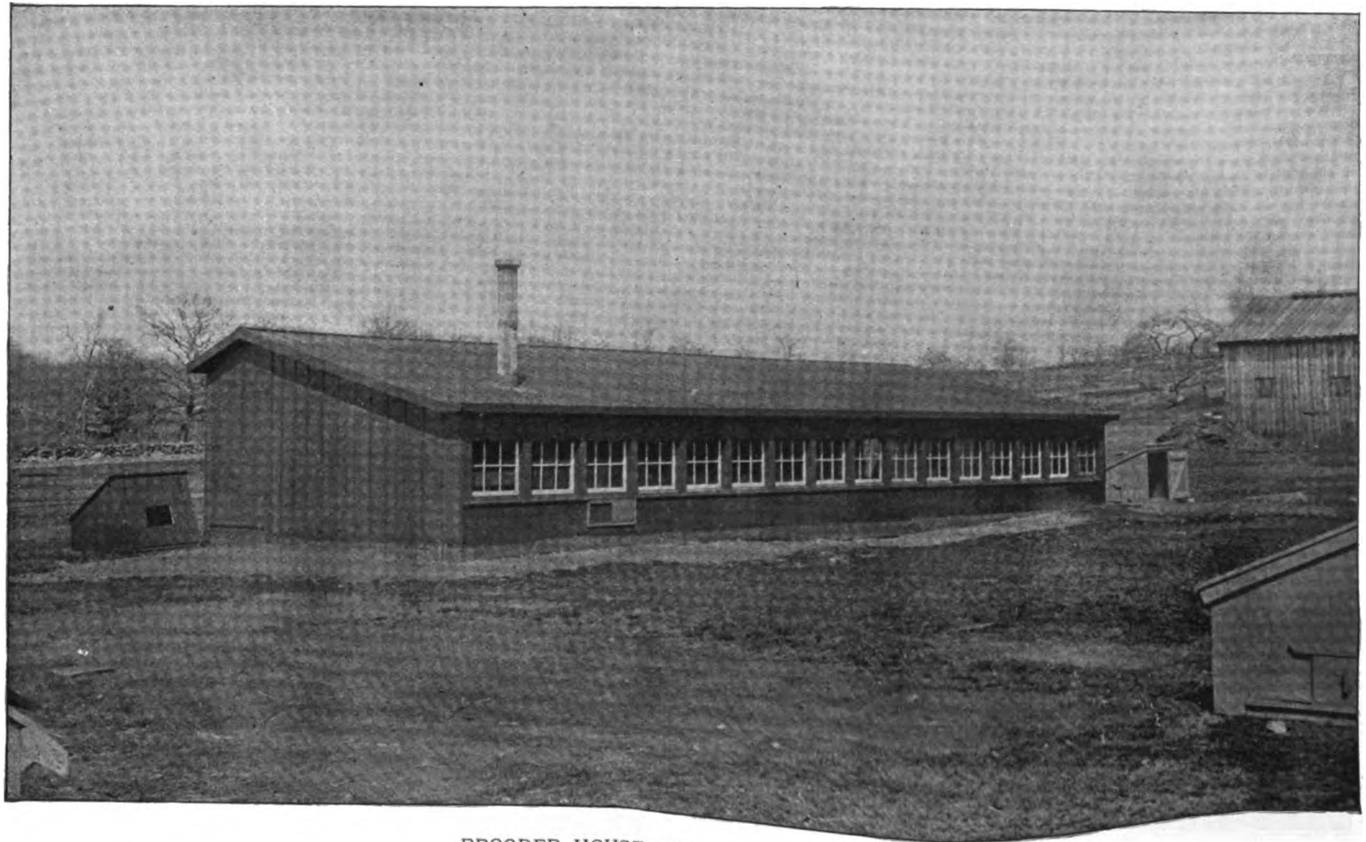
The brooders are boxed up, having hinged covers above and a slide in front, so they may be closed tightly, thus enabling one to confine most of the heat if necessary. They are also lighted by a pane of glass, 3 by 10, inserted in the front of each. The brooders are about 2½ feet from front to back; the passageway being 3 feet wide, leaves the pens about 9½ feet long. There are eleven of these indoor pens, six of them 2½ feet wide and five 5 feet wide. The brooders are of the same width as the pens and a foot high. They are not enclosed within the pens but their slides open into them. One-inch mesh, wire netting is used for the partitions. Doors open out over the brooders at the back of each pen and

give access from the passage way. The brooders, not being in the pens, are more easily looked after; the covers may be raised for ventilation or thrown back entirely, to give more heat to the building. The pipes in the brooder nearest the heater are 4 or 5 inches from the ground and 10 inches high at the other end, but the chambers may be filled up and the distance lessened, if desired. The pens were made of a width to contain one or two windows. The windows are 28 by 23 inches and are located high enough to give room for a slide door beneath, 8 inches high. These doors are half as long as the space beneath the windows. This building and system of piping has up to the present time proved satisfactory. The building is not floored but was made rat proof in the following way: The earth was excavated to the depth of 12 inches below the bottom of the sills. Hemlock boards one foot wide were nailed to the posts upon which the sills rest and close up to the sill around the building, and the entire ground surface inside the building was then covered with wire netting, half inch mesh, laced together with wire at all joints and extending up to the sills where it was securely fastened. The house was then filled, level with the sills, with fine gravel.

An illustration of this building is given opposite.

The work with incubators has been subordinate to other experiments. As good success has been had in hatching with incubators as with hens. When large numbers of chickens are to be reared there is no question as to the great advantage derived from using incubators and brooders. The new "Challenge" incubator gives as good satisfaction as any machine we have tried (Monarch, old style, and Prairie State) and is run with the least labor.

Experiments in caponizing were continued the past season, and birds were operated upon here and in various parts of the State to teach the operation. Capons were shown at the several Agricultural Fairs and at the winter Poultry Exhibition. Bulletin No. 20, Dec., 1892, gives the results of the experiments of two seasons and our study of the subject; the method of operating and the



BROODER HOUSE, FROM A PHOTOGRAPH.

various tools used are also illustrated and described. Arrangements have been made to give, at the Station, free instruction in caponizing to any one living in the State.

A number of ducks and geese were reared, and an experiment to learn how crosses between Embden and Toulouse geese compare in growth and weight, with each breed, pure, as well as to show which cross is the more desirable, has been arranged for the coming season.

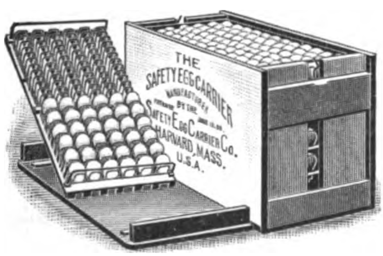
The "Neponsett" Red Rope Roofing paper, manufactured by F. W. Bird & Son, East Walpole, Mass., and sold by most dealers, used for covering the buildings, gives satisfaction, being water and wind proof, and we have learned that others who have given it a much longer test are equally well satisfied with its desirability. It has here received two coats of paint as soon as put on.

A considerable number of letters containing questions relating to the poultry industry have been answered during the year.

The New Bedford, Worcester and New York City Poultry Exhibitions have been visited in the interests of this Division and much valuable information thereby gained.

DONATIONS.

The Safety Egg Carrier Co., of Harvard, Mass., have donated a sample of their egg carrier and we feel that it is worthy of being brought to the notice of shippers, especially those who supply "Gilt Edge" goods to families and stores. See illustration.



Dr. W. A. Tremaine, of 123 Academy Ave., Providence, presented this Department with a Physician's Head Mirror with which to attempt caponizing by lamp light; and an atomizer having a nozzle pointing downward was also donated by Geo. P. Pilling & Son, 117 S. Eleventh St., Philadelphia, Pa.

APICULTURAL DIVISION.

SAMUEL CUSHMAN.

The sixteen colonies prepared for winter in the fall of 1891 came through without the loss of a colony and all were soon very populous. They were made use of last spring to teach a class of students the management of bees. Two colonies were made worthless by illustrative manipulation but as the season was an unusually good one for honey, we were able, by doubling up a number of colonies (very little increase in the number of colonies being allowed), to get an unusually large crop for this State. Very little honey was gathered in June but the flow was such in July that on August 8th, 372½ pounds of well ripened honey were extracted, and enough was also left in the hives to give the bees sufficient stores to last until the fall harvest, which rarely fails in this section. The greatest amount taken at this time from one of these powerful colonies was 58½ pounds. Another gave 50 pounds. In September every condition favored a large harvest from golden rod and asters. When this was over the surplus was removed, leaving a sufficient number of full combs with each colony to insure abundant supplies for wintering.

On October 11th and 12th this surplus, most of which was fall honey—although a part was summer honey that was not removed before—was extracted, and amounted to 466½ pounds. The strong colony that had yielded 50 pounds in August gave 67 pounds more at the end of the season, another that gave 40¾ pounds in August

yielded 45½ pounds more. The hive that yielded 58½ pounds, now gave 26 pounds more. The weakest colonies had more than enough for the winter.

This yield of 839 pounds of extracted honey and 87 pounds of honey in the comb, in one season, from sixteen colonies, (spring count) would not have been secured had they been allowed to double or thribble in number. In ordinary hives the bees would have had no place to put so much honey. The tiers of hives containing empty combs, which were piled up over the strong colonies, were as important in securing this crop as the abundant honey flow. No feeding of any kind, either to stimulate brood rearing in the spring or for winter consumption, has been practiced during the past two seasons.

A part of this honey was bottled and exhibited at the Kingston and State Fairs. A good part of the crop was sold at wholesale to Blanding & Blanding, Druggists, 54 Weybosset St., Providence, and the remainder in this vicinity.

Eighteen colonies were prepared for winter.

A much larger building than the present Apiary work shop is urgently needed by this Division even if the Apiary is restricted to its present number of colonies. A separate room for storing, ripening and bottling honey, as well as another for use as a show room for the various sample hives collected by this Division is quite necessary.

METEOROLOGICAL SUMMARY.

*January 1, 1892, to January 1, 1893. Records made daily at 7 A. M., 2 P. M., and 9 P. M.**

L. F. KINNEY.

	JANUARY.			FEBRUARY.			MARCH.			APRIL.		
	1892.	1891.	1800.	1892.	1891.	1890.	1892.	1891.	1890.	1892.	1891.	1890.
Highest Barometer	30.60	30.45	30.56	30.58	30 48	30.40	30.67	30.52	30.35	30.47	30.52	30.33
Lowest Barometer	29.32	28.74	29.25	29.10	29.21	29.25	29.21	29.51	29.25	29.33	28.94	29.30
Mean Barometer	29.95	29.858	29.84	30.04	30.079	29.86	23.87	30.095	29.79	29.95	29.875	29.86
Highest Temperature	57.°	59.°	63.°	46.°	58.°	64.°	49.°	59.°	67.°	76.°	76.°	70.°
Lowest Temperature	3.°	12.°	8.°	4.°	5.°	10.°	12.°	1.°	5.°	25.°	20.°	24.°
Mean Temperature	29.°	31.5°	36.4°	29.2°	32.1°	35.2°	32.7°	32.8°	33.5°	54.°	44.9°	44.7°
Prevailing Winds	S. W.	S. W.	N. W.	N. W.	S. W.	N. W.	S. W.	N. W.	N. W.	S. W	S. W.	S. W.
Total Rain and Melted Snow	5.39 in.	7.31 in.	3.02 in.	1.72 in.	7.26 in.	3.30 in.	4.09 in.	7.97 in.	9.83 in.	3.30 in.	4.70 in.	4.27 in.
Number of days on which the cloudiness averaged 8 or more on a scale of 10	12	15	15	18	11	14	17	7	10	15	4	5
Number of days on which the cloudiness averaged 3 or less on a scale of 10	7	4	8	8	2	7	12	14	4	14	15	11
Number of days on which .01 of an inch of Rain fell	10	9	11	5	6	13	6	5	16	7	8	10

* Barometric readings reduced to the sea level and a temperature of 32° F., after January 1st, 1891.

METEOROLOGICAL SUMMARY.—Continued.

*January 1, 1892, to January 1, 1893. Records made Daily at 7 A. M., 2 P. M., and 9 P. M.**

	May.			June.			July.			August.		
	1892.	1891.	1890.	1892.	1891.	1890.	1892.	1891.	1890.	1892.	1891.	1890.
Highest Barometer	30.46	30.47	30.17	30.38	30.16	30.20	30.39	30.35	30.20	30.20	30.22	....
Lowest Barometer	29.39	29.68	29.53	29.61	29.62	29.67	29.42	29.70	29.69	29.74	29.95	....
Mean Barometer	29.93	29.951	29.85	29.94	29.899	29.89	29.27	29.896	29.962	29.94	29.63	....
Highest Temperature	76.°	79.°	77.°	89.°	92.°	86.°	91.°	83.°	92.°	89.°	91.°	85.°
Lowest Temperature	38.°	30.°	36.°	41.°	42.°	54.°	47.°	49.°	47.°	56.°	48.°	38.°
Mean Temperature	54.°	53.1°	54.1°	66.°	63.6°	63.9°	70.4°	65.6°	69.1°	68.4°	69.3°	66.9°
Prevailing Winds	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.
Total Rain and Melted Snow	6.09 in.	1.76 in.	4.72 in.	1.61 in.	.70 in.	3.98 in.	3.43 in.	2.11 in.	1.88 in.	2.96 in.	2.69 in.	3.89 in.
Number of days on which the cloudiness averaged 8 or more on a scale of 10	24	5	9	21	7	10	20	12	5	22	5	10
Number of days on which the cloudiness averaged 3 or less on a scale of 10	5	14	10	9	13	10	6	11	9	5	6	2
Number of days on which .01 of an inch of Rain fell	14	5	11	6	3	8	9	6	7	6	10	9

* Barometric readings reduced to the sea level and a temperature of 32° F., after January 1st, 1891.

METEOROLOGICAL SUMMARY —Concluded.

*January 1, 1892, to January 1, 1893 Records made Daily at 7 A. M., 2 P. M., and 9 P. M.**

	September.			October.			November.			December.		
	1892.	1891.	1890.	1892.	1891.	1890.	1892.	1891.	1890.	1892.	1891.	1890.
Highest Barometer	30.46	30.36	30.25	30.40	30.51	30.19	30.38	30.71	30.12	30.45	30.46	30.44
Lowest Barometer	29.51	29.67	29.55	29.45	29.48	29.12	29.53	29.48	29.5	29.38	29.34	29.27
Mean Barometer	30.10	20.084	30.01	29.89	29.986	29.73	29.98	30.117	29.78	29.92	30.053	29.868
Highest Temperature	75.°	82.°	80.°	76.°	78.°	75.°	64.°	62.°	67.°	53.°	65.°	52.°
Lowest Temperature	41.°	48.°	34.°	30.°	20.°	32.°	18.°	9.°	14.°	0.°	7.°	1.°
Mean Temperature	60.4°	64.3°	61.4°	50.27°	49.7°	49.8°	40.23°	40.3°	41.3°	28.8°	39.5°	27.3°
Prevailing Winds	S. W.	S. W.	S. W.	S. W.	S. W.	N. E.	S. W.	S. W.	S. W.	S. W.	S. W.	N. W.
Total Rain and Melted Snow	2.48 in.	2.20 in.	3.93 in.	1.64 in.	6.72 in.	9.43 in.	6.20 in.	2.99 in.	.96 in.	2.02 in.	3.73 in.	4.71 in.
Number of days on which the cloudiness averaged 8 or more on a scale of 10	15	3	14	17	8	15	21	10	5	22	8	10
Nvmber of days on which the cloudiness averaged 3 or less on a scale of 10	11	9	9	10	9	6	7	10	11	8	9	12
Number of days on which .01 of an inch of Rain fell	5	6	10	5	7	16	7	6	3	9	10	6

* Barometric readings reduced to the sea level and a temperature of 32° F., after January 1st, 1891.

ACKNOWLEDGMENTS.

From Secretary of Agriculture, Hon. J. M. Rusk, and from the Department of Agriculture have been received the following reports and publications: Report of the Secretary of Agriculture for 1891. Bound copy of Experiment Station Record, Vol. II., August, 1890,—July, 1891. First Report of the U. S. Board on Geographic Names. Bound copy of Illustrations of North American Grasses, Vol. I. Grasses of the South-west. Reports of the Division of Statistics, Division of Entomology, Division of Vegetable Pathology, Division of Botany and Division of Chemistry, besides Miscellaneous Bulletins. The Experiment Station Record and Bulletins. From Mark W. Harrington, Chief of Weather Bureau; Monthly Weather Review, and various Reports and Publications issued by that Bureau, including various back numbers of Weather Reports. From the Census Office, Census Bulletins issued during 1892.

From Bureau of American Republics, Washington, D. C., have been received Bulletin 31, Costa Rica; Bulletin 32, Guatemala; Bulletin 34, Venezuela; Bulletin 35, Breadstuffs in Latin America. From the Bureau of Statistics, Reports from the Consuls of the United States, Nos. 142-145.

The following State Reports and Publications have been received. Report of the R. R. Commissioner for 1891, donated by Commissioner E. L. Freeman. Report of the Board of State Valuation made to the General Assembly at its January Session, 1892. Fourth and Fifth Annual Reports of the Commissioner of Industrial Statistics, presented by Commissioner A. K. Goodwin.

Annual Reports of the General Treasurer, for the years 1886, 1889, 1890 and 1891, donated to the Chemical Division. From the State Board of Agriculture, Seventh Annual Report, George A. Stockwell, Secretary.

The Agricultural Gazette of New South Wales for the year 1892, presented by Director H. C. L. Anderson. Annual Report of the Department of Agriculture, 1890–'91, Brisbane, Queensland, Australia, E. M. Shelton, Instructor in Agriculture. Annual Report of the Department of Agriculture for the Province of Ontario, for the year 1891; compliments of John Dryden, Minister of Agriculture.

Twenty-eighth and Twenty-ninth Annual Reports of the Secretary of the Michigan Board of Agriculture, compliments of President Clute. Thirty-ninth Annual Report of the Secretary of the Massachusetts Board of Agriculture, William R. Sessions, Secretary. Annual Report of the Nebraska State Board of Agriculture for 1890, R. W. Furnas, Secretary. Report of the Connecticut Board of Agriculture and Experiment Stations for 1891, T. S. Gold, Secretary. Thirty-fourth Annual Report of the Secretary of the Maine Board of Agriculture for 1891–'92, B. Walker McKeen, Secretary. Twelfth Vermont Agricultural Report by the State Board of Agriculture for the years 1891 and '92, W. W. Cooke, Secretary.

Tenth Annual Report of the New York Agricultural Experiment Station, Dr. Peter Collier, Director. Bound copy of "New York Farmers," from 1882–1891, Jonathan Thorne, Secretary. Also from the same source, Proceedings of the "New York Farmers," for 1891–'92. Thirteenth Annual Report of the Secretary of State of the State of Michigan relating to Farms and Farm Products, Robert R. Blacker, Secretary. A Study of the Proteids of the Corn or Maize Kernel, from Director Johnson, Experiment Station, New Haven, Conn. Common Injurious Insects of Kansas, presented by the author, V. L. Kellogg. Annual Report of the State Board of Horticulture of California, B. M. Lelong, Secretary.

Thirty-fourth Annual Report of the Horticultural Society of Missouri, L. A. Goodman, Secretary. Transactions of the Massachusetts Horticultural Society for the year 1891, parts 1 and 2, Robert Manning, Secretary. Annual Reports of the Dairymen's and Creameries' Associations of the Province of Ontario. Report of the Dairy Commissioner of the State of New Jersey from 1886–1891 inclusive. (Donated to Chemical Division.) From the State Board of Health of Massachusetts, 2 vols., viz.: Part I., Report on Water Supply and Sewerage; Part II., Purification of Sewage and Water, published in 1890. Report for 1892, Missouri Botanical Garden, Wm. Trelease, Director. Talk About a Grass Garden, and Road Making and Maintenance, two pamphlets by Jas. Bradford Olcott, South Manchester, Conn. Wisconsin Farmer's Institute, from W. H. Morrison, Supt. From Hon. Amos Perry, pamphlets entitled: Discourse before the R. I. Historical Society; Rhode Island's Adoption of the Federal Constitution; The Library and Cabinet of the R. I. Historical Society. Fourteenth Annual Report of the Providence Public Library, Wm. E. Foster, Librarian.

Vol. IV., Holstein Friesian Advanced Register, from S. Hoxie, Yorkville, N. Y. 7 vols., Ayrshire Record, Ayrshire Breeder's Association, from Henry E. Smith, Treasurer, Enfield, R. I. Maine State Jersey Herd Book, N. R. Pike, Secretary, Winthrop, Maine. Red Polled Herd Book, Vol. IV., 1892, J. McLain Smith, Secretary, Dayton, O. The American Cotswold Record, Vol. V., from George Harding, Secretary, Waukesha, Wisconsin. Vol. XII., American Hereford Record, from the Association, C. R. Thomas, Secretary. Annual Reports and Bulletins of all the Experiment Stations.

Newspaper Exchanges.

The Baltimore Sun, Baltimore, Md.
Mirror and Farmer, Manchester, N. H.
Boston Weekly Globe, Boston, Mass.
The National Provisioner, New York, N. Y.

The American Homestead, Omaha, Neb.
The Holstein Friesian Register, Boston, Mass.
The Toledo News, Toledo, Ohio.
The Industrial American, Lexington, Ky.
The Practical Farmer, Philadelphia, Penn.
The American Agriculturist, New York, N. Y.
The Louisiana Planter, New Orleans, La.
The Southern Cultivator and Dixie Farmer, Atlanta, Ga.
Home and Farm, Louisville, Ky.
The Sugar Beet, Philadelphia, Penn.
The Pomona Herald, Providence, R. I.
Sentinel Advertiser, Hope Valley, R. I.
The New Dairy, New York, N. Y.
The Pharmaceutical Era, Detroit, Mich.
Hospodar (*Bohemian*) Omaha, Neb.
The University Record, Ann Arbor, Mich.
The Naturalist's Leisure Hour, Philadelphia, Penn.
The Agricultural Epitomist, Indianapolis, Ind.
The American Cultivator, Boston, Mass.
The American Horse Breeder, Boston and New York.
Western Farmer and Stockman, Sioux City, Iowa.
The American Grange Bulletin and Scientific Farmer, Cincinnati, Ohio.

Four Nos., Proceedings of American Philosophical Society, Philadelphia, Penn.

REPORT OF THE TREASURER

The Rhode Island State Agricultural Experiment Station in account with the United States Appropriation.

DR.

1892.	To receipts from the Treasurer of the United States as per appropriation for year ending June 30, 1892, under Act of Congress approved March 2, 1887......		$15,000 00

CR.

June 30.	By Salaries	$8,027 96	
	Labor................................	2,840 65	
	*Supplies and repairs........	2,225 32	
	Freight and express	348 33	
	Library and printing	394 75	
	Tools and Machinery...................	223 11	
	Scientific Instruments..........	3 35	
	Chemical apparatus and supplies.......	242 27	
	Furniture.....................	17 54	
	Live stock....................	442 33	
	Travelling......	182 56	
	Incidentals.......	51 83	
		$15,000 00	$15,000,00

*Supplies and repairs itemized as follows: Building repairs, $40.06; fertilizers and manure, $600.00; hay, grain and feed, $852.62; repairs, $121.55; seeds and plants, $306.48; fuel, $70.26; sundries, $234.35.

This certifies that we, the undersigned, authorized auditing committee of the Board of Managers of the Rhode Island College of Agriculture and Mechanic

Arts, have examined the accounts of the Treasurer of the Agricultural Experiment Station for the fiscal year ending June 30, 1892, and that we find the receipts for the time named to have been $15,000.00, and that the same has been expended, for which satisfactory vouchers, correctly classified as above, are on file, and the same agrees with the Treasurer's account, and that there is no unexpended balance.

CHARLES J. GREENE,
NATHAN D. PIERCE, JR.,
CHANDLER H. COGGESHALL.
} *Auditing Committee.*

I hereby certify that the above is a true copy from the books of account of the Institution named.

MELVILLE BULL,
Treasurer of the Rhode Island College of Agriculture and Mechanic Arts.

I hereby certify that the above signature is that of the Treasurer of the Rhode Island College of Agriculture and Mechanic Arts.

CHAS. O. FLAGG,
President, Board of Managers, Rhode Island College of Agriculture and Mechanic Arts.

Melville Bull, Treasurer, in account with the Rhode Island Agricultural Experiment Station.

DR.

1892.			
June 30.	To farm receipts		$740 67
	" State "		875 00
	Interest		61 88
			$1,677 55

CR.

	By Salaries	$875 00	
	Supplies and repairs	553 80	
	Roads and water supply	14 95	
	Fertilizer inspection	126 81	
	Balance on hand	106 99	
		$1,677 55	$1,677 55

DR.

1890.		
May 24.	To receipts from Treasurer of the United States as per appropriation, made by Special Act of Congress on April 4, 1890	$15.000 00
1892.		
June 30.	To interest on above	533 90
		$15,553 90

CR.

1892.			
June 30.	By Amount rendered in last Account	$5,297 09	
	Salaries	825 00	
	Labor	2,178 85	
	Supplies and repairs	1,099 56	
	Freight, express, etc	37 96	
	Library and printing	818 86	
	Tools and machinery	418 75	
	Scientific instruments	448 05	
	Chemical apparatus and supplies	333 60	
	Furniture and general fittings	100 30	
	Live stock	380 63	
	Travelling	99 55	
	Incidentals	171 92	
	Grading	555 54	
	Balance unexpended	2,788 24	
		$15,553 90	$15,553 90

This is to certify that the undersigned, Auditing Committee of the Board of Managers of the Rhode Island College of Agriculture and Mechanic Arts, have examined the accounts of Melville Bull, Treasurer, ending June 30, 1892, and the vouchers corresponding therewith, and find the same correct.

CHARLES J. GREENE,
NATHAN D. PIERCE, JR.,
CHANDLER H. COGGESHALL, } *Auditing Committee.*

BULLETINS

AND

ANNUAL REPORT

OF THE

State Agricultural Experiment Station,

FOR THE

YEAR 1892.

PROVIDENCE:
E. L. FREEMAN & SON, PRINTERS TO THE STATE.
1893.

INDEX

TO THE

BULLETINS AND ANNUAL REPORT

OF THE

STATE AGRICULTURAL EXPERIMENT STATION

FOR THE YEAR 1892.

NOTE.—For pp. 1-26 see Bul. 15; pp. 27-42, Bul. 16; pp. 43-50, Bul. 17; pp. 51-58, Bul. 18; pp. 59-70, Bul. 19; pp. 71-112, Bul. 20; pp. 113-258, 5th Annual Report.

NOTE.—For pp. 1-26 see Bul. 15; pp. 27-42, Bul. 16; pp. 43-50, Bul. 17; pp. 51-58, Bul. 18; pp. 59-70, Bul. 19; pp. 71-112, Bul. 20; pp. 113-258, 5th Annual Report.

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NOTE.—For pp. 1-26 see Bul. 15; pp. 27-42, Bul. 16; pp. 43-50, Bul. 17; pp. 51-58, Bul. 18; pp. 59-70, Bul. 19; pp. 71-112, Bul. 20; pp. 113-258, 5th Annual Report.

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State of Rhode Island and Providence Plantations.

SIXTH ANNUAL REPORT

OF THE

RHODE ISLAND

AGRICULTURAL EXPERIMENT STATION,

1893.

PART II

OF THE

SIXTH ANNUAL REPORT

OF THE

BOARD OF MANAGERS

OF THE

Rhode Island College of Agriculture and Mechanic Arts,

MADE TO THE

GENERAL ASSEMBLY AT ITS JANUARY SESSION, 1894.

[PART I OF THIS REPORT—COLLEGE CATALOGUE—IS PRINTED UNDER SEPARATE COVER.]

PROVIDENCE, R. I.
E. L. FREEMAN & SON, PRINTERS TO THE STATE.
1894.

BOARD OF MANAGERS

OF THE

RHODE ISLAND

COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

MELVILLE BULL, - - - - - -	Newport County.
C. H. COGGESHALL, - - - - -	Bristol County.
CHARLES O. FLAGG, - - - - -	Providence County.
NATHAN D. PIERCE, JR., - - - -	Kent County.
CHARLES J. GREENE, - - - - -	Washington County.

OFFICERS OF THE BOARD.

CHARLES O. FLAGG, President, - -	P. O., Kingston, R. I.
CHARLES J. GREENE, Clerk, - -	P. O., Kenyon, R. I.
MELVILLE BULL, Treasurer, - -	P. O., Newport, R. I.

EXPERIMENT STATION STAFF.

CHAS. O. FLAGG, B. Sc., - -	Director and Agriculturist.
L. F. KINNEY, B. Sc., - - - - -	Horticulturist.
H. J. WHEELER, Ph. D., - - - - - -	Chemist.
SAMUEL CUSHMAN, - -	Apiarist and Poultry Manager.
J. D. TOWAR, B. Sc., - - - -	Assistant Agriculturist.
B. L. HARTWELL, B. Sc., - - - -	Assistant Chemist.
H. F. ADAMS, - - - - - - - -	Farmer.
MISS A. R. FRENCH, - - - - - - -	Clerk.

The publications of the station will be mailed free "to such individuals actually engaged in farming as may request the same." The station desires the co-operation of the farmers of the State in the work of investigation, and any facts concerning unusual animal or vegetable growth or disease, are solicited. Visitors are always welcome. Railroad station, telegraph, express and post office, Kingston, Rhode Island.

LETTER OF TRANSMITTAL.

To His Excellency, D. Russell Brown, Governor, and the Honorable the General Assembly of the State of Rhode Island at its January Session, 1894.

KINGSTON, January 31st.

I have the pleasure to present herewith, in compliance with the statute of the State and the Congressional act of March 2, 1887, the Report of the Director and the heads of the various Divisions of the Rhode Island Agricultural Experiment Station, together with that portion of the Report of the Treasurer of the Board of Managers of the R. I. College of Agriculture and Mechanic Arts relating exclusively to the Experiment Station.

Respectfully submitted.

For the Board of Managers,

CHAS. O. FLAGG,

President.

REPORT OF THE DIRECTOR.

CHAS. O. FLAGG.

No changes have been made in the *personnel* of the station staff during the year past, and the work outlined for the season has been prosecuted by the various divisions with vigor and, we believe, a fair amount of success.

WORLD'S COLUMBIAN EXPOSITION.

During the autumn of 1893, samples of soil were taken from eight (8) different localities within the State as a part of a collective exhibit of the soils of the United States made by the Agricultural Colleges and Experiment Stations. These soils were collected under the direction of Dr. H. J. Wheeler, and samples taken at the same time for analysis by the Station, and also for physical examination, at the request of Prof. Milton Whitney of Johns Hopkins University. The samples for the Fair were to be uniform in size, about four (4) inches square in area, thirty-six (36) inches deep, and placed in a box in a *natural condition* so as to represent the actual character of the soil to that depth. The samples were taken in the following way: A location having about an average soil for that section and apparently free from large stones was chosen, and a hole dug about three (3) feet in diameter and three and a half (3½) feet deep. The empty box was then placed against the earth, with one end at the surface,

and a perpendicular column marked out with a knife. The outside was then cut away until the box could be fitted over the column of earth and the whole removed without in any way disturbing the relative position of the surface and subsoil. A tight board cover was fastened upon the box for shipment, to be replaced with glass at Chicago. Samples were taken from the following localities :

No. 1.—South Kingstown — "Kingston Plain."—Station farm, west end. Herbage: fine grasses. Agricultural soil (that portion on the surface, dark in color by addition of vegetable matter): three and three-fourths (3¾) inches deep. Subsoil : fine yellow sandy loam; loam free from stones; underlaid at the bottom of the sample with open gravel.

No. 2.—South Kingstown — "Kingston Hill." Station farm, east end. Herbage: fine grasses. Agricultural soil: five (5) inches deep. Subsoil: clay and hard-pan.

No. 3.—Warwick—Near Greenwood R. R. Station. Herbage: running blackberries, golden-rod, and wild, coarse grasses. Agricultural soil: five and one-half (5½) inches deep. Subsoil: coarse gravel.

No. 4.—Lincoln—Lime Rock. Old pasture land. Herbage: fine grasses. Agricultural soil: six and one-half (6½) inches deep. Subsoil: yellow clay loam with frequent stones.

No. 5.—New Shoreham—Block Island. Hill farm about one mile west from the harbor. Herbage: fine grasses. Agricultural soil eight (8) inches deep. Subsoil: strong yellow loam with few stones; sandy at the bottom.

No. 6.—Middletown—Near house of Mr. Henry Bull. Pasture not plowed in twenty years. Agricultural soil: ten (10) inches deep. Subsoil: clay hard-pan, with frequent broken slaty rock.

No. 7.—East Providence—East of Silver Spring R. R. Station. Old pasture, not plowed for many years. Agricultural soil: six and one-half (6½) inches deep. Subsoil: open clay loam, with occasional stones.

No. 8.—South Kingstown—Swamp near Green Hill. Meadow muck from deposit of organic matter with some silt, about four (4) feet in depth.

A description of these soils, including chemical analyses, will be published later by the Chemical Division.

For exhibition in the fertilizer alcove of the Collective Experiment Station Exhibit, the Chemical Division prepared a collection of thirteen (13) large glass bottles of waste fertilizing materials from Rhode Island industries and nine (9) bottles of certain seaweeds (dried) used for manurial purposes along the coast.

List of Waste Fertilizing Materials (13 bottles).

Crude Sun-dried Fish	As produced by Daniel T. Church and W. J. Brightman & Co. of Tiverton.
Fine Ground Sun-dried Fish	
Crude Acid Fish	
Fine Ground Acid Fish	

Crude Tankage	As produced by L. B. Darling Fertilizer Co., Pawtucket.
Fine Ground Tankage or Animal Dust	
Coarse Bone	
Fine Ground Bone	
Dried Blood	

Fertilizer obtained from garbage and refuse of the city of Providence, treated by the "Simonin Process." Riverside Chemical Works, Providence.

Wool waste. The ground residuum from the water used in the process of "scouring" or washing wool.

Picker waste. Waste and dirt separated by wool picking machines. River Spinning Co. or Belgian Yarn Co., Woonsocket.

Cotton dirt. Material obtained in purifying the cotton employed in making wadding. Used chiefly as an absorbent in stables. Union Wadding Works, Pawtucket.

List of Dried Seaweeds (9 bottles).

Laminaria saccharina.—Ribbon-weed, Kelp, Tangle.
Laminaria digitata.—Broad-leafed Kelp, Devil's Apron, Tangle.
Rhodymenia palmata.—Dulse, Dillesk.
Ascophyllum (Fucus) nodosum.—Round-stalked rock-weed.
Fucus vesiculosus.—Flat-stalked rock-weed.
Phyllophora membranifolia.
Chondrus crispus.—Irish or Carrageen moss.
Lostera marina.—Eel-grass, Grass-wrack.
Polydes rotundus.

Nine (9) charts, each twenty-two by twenty-eight (22×28) inches in size were prepared by Mr. J. D. Towar for the Agricultural Division—six (6) of which illustrated the co-operative field experiments; one (1) the application of lime in connection with sulphate of ammonia; one (1) the method of laying out permanent experiment plots; and one (1) the manure pit and drains. A topographical map of the State also gave the location of the Experiment Station.

FERTILIZER INSPECTION.

The collection and analysis of samples of all the commercial fertilizers or materials used for fertilizers, sold or offered for sale within the State at the price of ten (10) dollars or more per ton, has been efficiently performed by the Station chemist and his assistant as required by law. The results have been published in Bulletins Nos. 23, 24 and 26, issued by authority of the Director of this Station, and a report including all the analyses in detail made to the State Board of Agriculture as prescribed in the act, the general direction and enforcement of the fertilizer inspection law being placed in their charge.

One hundred and five (105) samples were collected and analyzed. The quality of the goods sold the past year has not been quite as generally equal to the guarantees as those of the year previous, but better than in 1891, as is shown by the following:

	1891.	*1892.*	*1893.*
	Per cent.	Per cent.	Per cent.
Percentage of constituents equal or above the guaranty	71.06	80.71	75.74
Percentage of constituents less than .3 per cent. below the guaranty	10.64	9.00	13.77
Percentage of constituents more than .3 per cent. below the guaranty	18.30	10 29	10.49

It is a matter of great importance to the farmers of the State whether or not the fertilizers are as good as they are guaranteed to be, and those manufacturers who maintain from year to year a standard equal to their guaranty cannot fail to gain the confidence of the purchaser.

COMMERCIAL VALUATION.

We find in the columns of the agricultural press occasional discussion of the advisability of the Experiment Stations placing a commercial valuation upon the fertilizers analyzed. In connection with the analysis, the selling price of the fertilizer is published in one column, and in another the total value at which the three elements,—nitrogen, potash and phosphoric acid,—found by analysis in the sample could have been purchased in the best forms. This value is obtained by multiplying the number of pounds of each of the three elements found in a ton by the price per pound for which they could have been purchased in agricultural chemicals and fertilizer stocks for six months preceding March 1st in each year. Potash is valued at one of two (2) prices, varying as the material is found to contain or be free from chlorides. Phosphoric acid is valued at one of three (3) prices according to its condition of solubility, and nitrogen is also given one of three (3) values, varying with its source. This constitutes *commercial valuation.* It simply shows the farmer the amount of money necessary to purchase an equal number of pounds of the

three elements in the best forms as compared with the selling price of the mixed fertilizer. Those who oppose the system of commercial valuation do so upon the ground that the chemist cannot, by analysis, tell the source of organic nitrogen, whether from dried blood, meat, fine dried fish or equally good material, and ground leather or some other insoluble and inert form, and that no account is taken of the mechanical condition. In regard to the latter, there is comparatively little difference in most brands of mixed fertilizers. Self-interest requires every manufacturer to put his goods upon the market in a perfect mechanical condition, fine and dry, and the farmer is just as good a judge of that point as the chemist; however, the latter frequently uses a carefully graded set of seives in making such comparisons. In regard to the nitrogen, the chemist can determine if any is present in the form of ammonium salts or nitrate of soda, and if so it is valued accordingly; but if present in an organic form he does not attempt to determine its source (unless suspicious of fraud, when the sample is subjected to a rigid microscopical examination), but gives it the value assigned to the best forms of dried blood, pure ground dry fish, meat, etc. The law positively forbids the sale of fertilizers containing leather unless so stated on the package. From intimate knowledge of fertilizers and fertilizing materials of all kinds the chemist is far better qualified to give a just and fair valuation to any mixed fertilizer than the farmer who does not see the goods but has simply the table of analyses and the prices of the elements per pound and is expected to figure the valuation for himself. Those manufacturers and dealers who oppose the calculation and publishing of a commercial valuation by the chemist are strongly in favor of having the farmer provided with the data and educated to figure those values for himself, which is certainly desirable; but if commercial valuation, when figured by the chemist in the light of his knowledge of the goods, is misleading—as some affirm, how much more so when figured by the farmer with tables only as his source of information? While a fertilizer is always purchased with the idea of

crop production, neither the selling price nor the commercial valuation is any criterion of its crop-producing or agricultural value under all circumstances. That depends upon the skill of the farmer using it, the land to which it is applied and the crop planted upon it. The crop must be adapted to the character and condition of the soil and the fertilizer must be adapted to both. The method of application, cultivation of the crop and climatic conditions must be such as to bring out the maximum influence of the fertilizer in order to determine its full agricultural value.

TEMPERATURE AND RAINFALL.

Arrangements were made March 1st, 1893, with Mr. Nathaniel Helme, for several years local weather observer in connection with the U. S. Weather Bureau, to make all meteorological observations for this Station, and his annual report may be found on subsequent pages.

The mean temperature has been lower than for four years. The average mean temperature of the three previous years is 48.5°, while that for this year is 46.5°—slightly below normal temperature. The average temperature for January, February, April, June, July and September was lower than the same months in 1892, January being 9.4° colder. There was very little or no change in the months of March, August and November, while each one was 3° warmer than the same months in 1892. The coldest day of the year was January 11th, 6° below zero; and the warmest, July 20th, 92°.

The normal rainfall for this locality is about 45 inches, but since 1889 it has varied from 64.54 inches to 42.58—the latter figures being the record for last year. There has been more precipitation this year, the total being 57.33 inches, or 14.75 inches more than last year. The rainfall of February was 9.14 inches, or more than five times as much as in the same month of 1892. July on the contrary gave but .95 of an inch, or less than one-third as much as fell in the corresponding month in 1892.

The following summary shows the number of clear, fair and cloudy days for the past four years, also the number of days on which one-tenth inch or more of rain fell:

	1893.	*1892.*	*1891.*	*1890.*
Clear	126	147	116	99
Fair	130	116	154	143
Cloudy	109	103	95	123
Rainy	131	89	83	120

The season on the whole has been an average one for the production of field and garden crops. Corn grew very slowly through the dry, warm weather of July, and was a little backward in consequence, but produced a fair crop. There was a very short supply of apples and other large fruits, and small fruits were hardly an average crop.

CHEMICAL DIVISION.

In addition to the work involved by the fertilizer inspection, quite a number of analyses of fertilizing materials and materials used for feeding purposes have been made, also analyses of well and spring waters, which are reported in their proper place. In connection with the Agricultural Division quite an amount of field experimental work has been undertaken, involving considerable labor both in the field and laboratory. The effect of dressings of carbonate of lime in connection with sulphate of ammonia and nitrate of soda has been carefully studied and information of much value and interest obtained. Further experiments in the same line will be made the coming season. In connection with the twentieth-acre co-operative corn experiments a series of pot experiments was instituted, using soil from the field which had

been under experiment for three successive years. These pots were located near the laboratory, and enclosed by a neat wire fence for protection from injury or accident.

HORTICULTURAL DIVISION.

The duty of providing a "College garden" was transferred in the early spring from the Agricultural Division to the Horticulturist and the expense borne by the College. This seemed wise, as the area under cultivation could be utilized in providing vegetables and small fruits for the boarding-house to better advantage than in any other way. The land heretofore devoted to "College garden" has been seeded to grass. The care of lawns and shrubbery around the laboratory and College buildings is a part of the work of this Division. Some new trees and shrubs have been set out. On Arbor Day, with the assistance of the students, maple trees were transplanted from the nursery to both sides of "Hendrick Avenue" leading south to the highway.

Last spring 212 packages of strawberry plants and chrysanthemums were distributed by mail to such as made a remittance sufficient to cover the expense of mailing. This was done to encourage the farmer or his family to set out small fruits for home use. Only a few plants were sent in each order, but enough to furnish desirable varieties for a beginning. Every farm can easily have small fruits in abundance for table use, and just how freely they will be used one does not realize until the experiment is made by growing a supply on the farm. The attention of the fruit-growers of the State has been called to the value of bordeaux mixture for preventing the leaf-blight of the pear. Experiments were conducted upon trees that for many years have borne only worthless cracked fruit, with profitable results. Details of the work may be found in Bulletin No. 27.

As stated a year ago, better greenhouse and cellar storage facilities are needed, and the necessity is emphasized by the growth of the College and increase of classes.

APIARY.

The same policy as last year has been followed in the management of the apiary. The colonies have been kept strong and vigorous, and all their energy devoted to honey production with very satisfactory results. The apiary numbered fifteen colonies, from which 635 pounds of extracted honey were secured, beside a sufficient supply to furnish the bees with food during the winter.

POULTRY DIVISION.

The work in this Division has been mainly a continuation of work in crossing fowls, crossing wild and domestic turkeys, and crossing Embden and Toulouse geese. The Indian game and Wyandotte crosses still maintain the supremacy in producing a hardy bird with plump, handsome body and abundance of breast meat.

Beside the pure wild gobbler mated with the Station flock of turkeys, arrangements were made with two successful turkey-raisers to use only high-grade wild gobblers for breeding, the Station to have the privilege of selecting the best young "toms" for sale as breeders at cost to such turkey-raisers in the State as desired to improve their breeding stock by a cross with wild blood. The stock which has been so distributed will undoubtedly prove of great benefit to the industry. Attention is being given to the study of the diseases of poultry, especially the so-called "Blackhead" of turkeys. Any breeder so unfortunate as to have serious losses from that or any other disease will confer a favor by notifying the Poultry Division of the facts in the case.

The experiments in crossing geese were commenced this year and will be continued another season, when this Division expects to be able to present some results of value to this industry. Rhode Island, although small in area, has a coast line aggregating about 400 miles, besides numerous fresh water ponds and

streams, all of which give ample opportunity for increased attention to this branch of the poultry industry.

AGRICULTURAL DIVISION.

The co-operative field experiments were continued upon three fields this season, and air-slacked lime was applied to a portion of some of the plots with very gratifying results, especially upon the Station farm. The reader is referred to the report of the experiments for particulars.

The experimental field work has this year been started in certain definite lines upon the permanent plots. In connection with the Chemical Division, important work has been done in studying the effect upon many agricultural crops of lime applied with and without nitrate of soda and sulphate of ammonia, and Dr. Wheeler has discussed this season's results quite fully in this report. Six crop-rotations have been laid out for the permanent plots—one of six years, three of five years, one of four years, and one of three years. These rotations occupy twenty-eight one-tenth acre plots. One hundred and eighty-two plots have been employed by this Division in experimental work. The ten varieties of oats grown last year were again grown, and the product offered to the farmers of the State for seed.

Thirty-two varieties of leguminous plants were sown in rows for illustration and test with and without nitrogen. About five acres of land directly east of the permanent plots laid out last year were planted to corn without fertilizer in order that the natural yield might be obtained as a basis for experimental work. The field sown with oats was seeded to clover, one half of the field getting a dressing of air-slacked lime and the other not. The "catch" of clover was far superior on the limed portion. The same was true last year, and the clover crop from last year's seeding on the limed portion far exceeded that upon the unlimed part. The application of lime to our light plain lands in connection with potash and phosphoric acid seems to insure the growth of clover.

FARM CROPS.

The hay crop exceeded that of any previous year. The newly seeded fields about the Mechanical Building gave a crop of excellent quality. About 22 tons were cut and secured in good condition. Other fodder crops were 2½ tons of Hungarian, 4 tons of oats cut green and cured as hay, and 10 tons of corn fodder. Some 4 tons of oat straw and 2½ tons of rye straw were produced. The grain grown and allowed to ripen gave, on threshing, 138 bushels of oats and 53 bushels of rye; 540 baskets of corn were husked, and 200 bushels of carrots grown for feeding horses.

FARM STOCK.

The two pairs of oxen used in road building and clearing up pasture were kept through the winter on coarse fodders, and after the heavier part of the spring work was completed were turned to pasture and fattened for beef. Six horses were kept for use on the premises, two belonging to the College and four to the Station. There are eight head of neat stock: one Holstein cow, "Fabiola 3d" and her two heifer calves, "Fabiola's Lady" and "Fabiola Maid"; one Ayrshire cow, "Geneva Belle," and her bull calf; one grade Guernsey cow; one grade Ayrshire heifer, and one native cow. The Ayrshire bull "Geneva Boy" was turned to beef as he had become somewhat vicious. From a lot of eight pigs purchased rather more than a year ago, two sows were kept for breeders, and this fall two litters—fifteen pigs—raised; nine we shall keep through the winter with the purpose of having them for the butcher late in the spring. Believing that the breeding of good pigs is profitable for even the New England farmer, the Board of Managers authorized the purchase of a trio of Berkshire pigs—a boar and two sows. After some correspondence the pigs were purchased of Mr. James Riley, Thorntown, Indiana, who was a prize-winner on Berkshire pigs exhibited at the Chicago World's Fair. The sows—Helen, No. 544, and Gladys, No. 546—were both sired by Columbus, No. 28,701. The boar, Western Prince, No.

397, was sired by Ben Harrison, No. 311. These pigs are handsome specimens of their breed, and we believe the Berkshire to be the equal of any for the economical production of pork.

AGRICULTURAL FAIRS.

The Station made exhibits at the Washington County Fair of stock, poultry, honey, potatoes, grains and forage crops. Specimens of pears were exhibited illustrating the effect of spraying with Bordeaux mixture to prevent the blight. A large number of photographs illustrated the growth of various farm crops when fertilized with nitrate of soda and sulphate of ammonia with and without lime. A similar exhibit was made at the Rhode Island State Fair at Cranston.

PUBLICATIONS.

The following bulletins have been issued. From 5,000 to 5,500 copies of each number have been printed and comparatively few are now on hand. The supply of Bulletin No. 25 was exhausted some time ago, with the exception of a few reserved for public libraries. While the supply lasts, copies of the other numbers will be sent "to such individuals actually engaged in farming as may request the same." The bulletins are numbered consecutively in the order of their issue, but paged from the beginning of each year; the paging will continue through the annual report, and one index at the close of the year will cover all the publications issued during that time. In this way all who desire a permanent form can have bulletins and report of each year bound together in one volume with an index for convenient reference.

BULLETIN No. 21. JANUARY, 1893. PAGES 1-38.

BY H. J. WHEELER AND B. L. HARTWELL.

CONTENTS:

SEA-WEEDS: THEIR AGRICULTURAL VALUE; THE CHEMICAL COMPOSITION OF CERTAIN SPECIES.

BULLETIN No. 22. February, 1893. Pages 39–58.

BY L. F. KINNEY.

CONTENTS:

Strawberries: Cultivation and varieties.

BULLETIN No. 23. July, 1893. Pages 59–76.

BY H. J. WHEELER AND B. L. HARTWELL.

CONTENTS:

Fertilizers: Commercial and miscellaneous.

BULLETIN No. 24. August, 1893. Pages 77–84.

BY H. J. WHEELER AND B. L. HARTWELL.

CONTENTS:

Fertilizers: Analyses of commercial.

BULLETIN No. 25. September, 1893. Pages 85–124.

BY SAMUEL CUSHMAN.

CONTENTS:

Turkeys: Experiments with; management of by successful producers; wild turkey crosses, their desirability, and where they may be obtained.

BULLETIN No. 26. November, 1893. Pages 125–156.

BY C. O. FLAGG, H. J. WHEELER, J. D. TOWAR AND B. L. HARTWELL.

CONTENTS:

Fertilizers. Oats. Potato scab.

CORRESPONDENCE.

The number of inquiries for information of various kinds received by the members of the Station staff increases each year. While satisfactory answers cannot be given in all cases, yet as far as possible effort will be made to serve the farmers of the State in this way.

We would especially invite the citizens of the State to visit the College and the Station and see for themselves the work in progress.

In closing we would extend cordial thanks to all our co-workers for earnest and efficient service.

ROTATION OF CROPS.

CHAS. O. FLAGG.

In the opinion of many farmers the one thing needful for the successful production of crops is an abundant supply of stable manure or fertilizer. The growing of profitable crops without the use of one or both is not to be thought of for a moment. This idea has gained so firm a hold upon the minds of many that the fact that there are other *practical* and *economical* methods of producing crops is entirely eclipsed.

Manuring should stand on the same plane with *Cultivation*, *Rotation*, *Drainage* and *Irrigation*. Nature has so constructed some fields that neither artificial manuring, drainage nor irrigation are necessary for the production of abundant crops; upon other fields, either one, two or all three of these subjects demand attention. However it may be with those, *cultivation* and *rotation* are important aids in maintaining fertility upon all fields alike. The latter of these two subjects we will briefly discuss.

Few farmers in New England cultivate their farms in accordance with any established system of rotation—that is, the growing of certain crops in regular successive order upon the same field. Rotations vary in length according to the number of crops grown, and may occupy from two to fifteen or even more years. The term is used in systematic forestry to define the time occupied by the growth of a crop of wood or timber—that is, the time from the cutting of one crop to the time when a second cutting can be made on the same land, and hence has a different meaning from that applied to it in agriculture proper. An ideal rotation pre-

supposes the farm to include no waste or untillable land and to be divided into as many equal fields as there are years or crops in the rotation. In this way one field will be in each crop each year, but the *same crop* will rotate or be planted on field No. 1 this year, on field No. 2 next year, field No. 3 the following year, and so on to the end of the rotation, when it will be again planted on field No. 1. But such ideal conditions seldom exist in practice and on our rough New England farms are impossible. Nearly every farm, aside from "woodland," in this State has a larger or smaller area of land too hilly, rocky, gravelly or wet, to be profitably cultivated, and thus it is still unreclaimed and used only for pasturage. A certain area of meadow and swamps is used for the production of a coarse quality of hay, and as it cannot be plowed no other crop is ever grown.

The tillable land consists often of fields of irregular size and shape as the contour of the hills and the abundance of rocks will permit. These fields generally exhibit a far larger variety of soils than farms in a more level or prairie section possess. Some fields are too wet and cold to grow corn, while others are too gravelly to grow grass, and hence a rotation which shall include all the cultivated fields of the farm is hardly possible. If rotation is followed, it becomes necessary to have more than one system and adapt the crops and the length of the rotation to the various fields according to condition, soil and location. This often involves more care and study for a moderate-sized farm than is required with a single system of rotation upon a large one. To these reasons probably is largely due the fact that the New England farmer in general pays little regard to rotation, but is he wise in following up a hap-hazard system of cropping? Are there not good reasons why systematic rotation should be followed? Let us briefly recount some of them.

The idea that the intelligent arrangement of crops into a rotation increases the annual yield and helps improve and preserve the fertility of the field is not a new one nor confined to the days of modern agriculture. The old Romans had systems of rotation

short and imperfect, but in those days known to be better than constant cropping with one variety of plant. Farmers in England and on the Continent have had their systems of rotation in which, as in the old Roman systems, the "bare fallow" played an important part. Increase of population making greater demands upon the food supply and better knowledge of the laws which govern the growth of plants have changed and improved the systems of rotation followed in the most highly cultivated portions of Europe. The discovery of guano and the subsequent building up of the fertilizer trade in the utilization of all waste products of any value as a plant food, and the discovery of nitrate of soda, potash salts and phosphate-rock allowed the tenant farmer more liberty in the cultivation of crops than was possible when obliged to depend solely upon the fertilizers made upon the farm. This brings us face to face with the statement that in these days the farmer can purchase for cash the elements to grow his crops, while in those days fertility was maintained by a careful system of rotation. Is it not possible for our farmers to *pay more attention to rotation* and pay less money for fertilizers—or differently stated, paying an equal amount for fertilizers to get larger crops by adopting a proper rotation?

The primary reasons for rotation are found in the soil and the different demands for food which the various crops make upon it, as well as difference in capacity of various plants to collect their food. The soil serves to anchor the plant and furnishes a medium through which it may send its roots for food and moisture, in which capacity it acts as a great store-house. The dark-colored soil at the surface, varying in depth according to location, is generally due to the presence of organic matter—decaying leaves, stems and roots. Exposure of the soil to the free admission of air and action of frost hastens decomposition and therefore facilitates the formation of agricultural soil. This portion of the soil contains by far the larger percentage of plant food and is constantly reinforced by whatever fertilizer is applied, by the decay of roots and falling leaves and by dust and sediment from rain-water.

The soil beneath the dark agricultural soil, the subsoil, is thought by some of little consequence or value, but its influence is great upon the crop-producing power of the soil. It has much to do with the water supply, and of itself has more or less fertility besides some small amount which is washed down from the surface soil by rains.

As plants differ widely in their habit of growth above ground, so is there a difference below the surface in the root growth. Some have a large mass of fine thread-like roots which fill the surface soil, like some of the grasses; others have large roots which penetrate deep into the subsoil, like clover or root crops, and draw their supplies of food from the lower portions of the soil. In this way the deep-rooted plants grow upon supplies entirely beyond the reach of those having a shallow-rooted system, and herein we find a strong reason for the rotation of crops. Larger crops can be produced by a judicious combination of shallow and deep-rooted plants. Again, plants vary in their ability to secure a sufficient supply of food from the same soil. It is well known that rye will thrive upon land much too poor to grow a good crop of wheat or barley. The oat, perhaps, stands next to rye among the cereals in ability to extract nourishment from the soil. Some plants, while having sufficient power to secure an abundance of certain elements, lack the power to extract the small quantity of some other element essential to its growth. The turnip is a well-known illustration, in that fertilizers or manures containing a relatively large amount of soluble phosphates always give the best crops, notwithstanding the fact that the turnip is not especially rich in its content of phosphoric acid. The turnip plant simply has a low power of assimilating phosphoric acid from the soil, and unless a liberal amount of that element is supplied in a soluble form the crop is lessened.

In rotations, plants which are delicate feeders should be grown when the soil is full of available plant food, and be followed by strong feeders which will secure and use food left by the preceding crop.

When any crop is removed from the soil it carries certain elements of fertility with it, and repeated removals of the same crop without manuring will sooner or later exhaust most soils of those elements, so that further cultivation of that crop will be unprofitable. This was eminently true of the cotton fields of the South when there was less of diversified agriculture than at present. Cotton was planted year after year on the same field, the yield gradually decreasing until a point was reached where the crop would not pay the cost of cultivation and harvesting, when the field was said to be "worn out" and was discarded for others more productive. The "worn out" fields would quickly grow up to weeds and grass, and nature would begin the slow process of restoring them to a condition of fertility through the growth and decay upon and within the soil of a variety of plants. The rank growth of some of these plants is nature's contradiction as to the "worn out" condition of the soil, and proves that the soil is "worn out" only as related to cotton or plants requiring the same elements in the same or about the same proportions. A good system of rotation with thorough cultivation would go far toward indefinitely postponing the evil day of unprofitable crops.

The same elements serve in the main as food for most agricultural crops, but the relative quantities of each have a wide variation. If the following named crops produced the quantities stated upon an acre of ground each, they would remove the amounts of nitrogen, phosphoric acid and potash named in pounds. The figures for the potatoes do not include the tops, as they are seldom removed from the field.

	200 bush. Potatoes.	62½ bush. Oats and 1 ton Straw.	50 bush. Corn and 1 ton Stover.	2 tons of Clover Hay.	500 bush. of Swedish Turnips.
Nitrogen	39	49.1	66.1	78.8	67.2
Phosphoric Acid	20.4	19.5	27.2	23.4	16.8
Potash	68.4	37.0	40.4	78.	56.

A comparison of the figures shows that a potato crop uses but about half the nitrogen required by a corn, clover or turnip crop, and three-fourths as much phosphoric acid as the corn, nearly as much as the clover, and one-fifth more than the turnips; but of potash it demands nearly two-thirds more than the corn crop, and about one-eighth less than the clover crop. The clover crop makes fully as great a demand upon the soil as any of the others, but its mineral food is largely drawn from the lower part of the agricultural soil and from the subsoil, while it is able to obtain some considerable portion of its nitrogen from the atmosphere through the friendly bacteria which multiply within the nodules upon the roots. The large mass of roots left to decay within the soil adds to the quantity of organic matter, while the mineral elements are left near the surface for the use of other crops, so that, instead of an exhausting crop, clover is probably the best renovating crop which can be grown, and hence should find a place as often as possible in every sound system of rotation. Crops which draw heavily upon the supply of phosphoric acid in the soil should be followed by those which require but little, hence grain crops should be followed by root crops, and those in turn by grain and grass.

Hoed crops should be interspersed with grain crops that the ground may be kept free from foul growths and the plant food and moisture preserved for the use of the crop. Cultivation and stirring the soil frequently promotes the rapid formation of available plant food from the supplies of insoluble material in the soil, hence hoed crops have an important place in any rotation as a means of increasing fertility. Broad-leaved plants favor the development of soluble plant food in the soil by furnishing the conditions necessary for nitrification—that is, partial shade and protection from too great heat, while the surface soil is kept more moist because of less evaporation. Narrow-leaved plants do not shade and protect the soil as do broad-leaved ones.

Our farm crops vary in the season of their growth: some making most of it in the cool weather of fall and spring and

others only growing during the heat of summer. This is an important reason for a rotation of crops. It is becoming more and more recognized as a fundamental principle of agriculture that if we would prevent all waste of soluble plant food by leaching and evaporation the soil must be *kept covered with a growing crop at all seasons.* A soil full of active, hungry rootlets will not suffer by the leaching away of plant food, and the protection afforded the soil by the crop, especially in winter, has an important bearing upon the preservation of fertility. In England the bare fallow—that is, allowing the land to lie without producing any crop, and frequently harrowed or cultivated to prevent the growth of all weeds—is thought to render the land more productive and give fall sown grains, especially, a good start. But the climate of England is far different from our own. With her cloudy skies, moist air and frequent fogs and rains, the soil is kept moderately cool and moist—just the conditions to promote nitrification; while here, our hot sun, dry air and frequent drouths over-heat and over-dry the soil and furnish conditions decidedly *unfavorable* for the development of soluble plant food; therefore, to prevent waste, keep a crop growing upon the field as much of the time as possible.

Rotation of crops is important upon a dairy or stock farm, because a variety of crops is provided, and cattle thrive better upon a good assortment of foods than when confined to one article of diet. If soiling is practiced, rotation is still more important, in order that a succession of green crops, in just the right condition for feeding, may be had through the season.

Rotation offers still another advantage in distributing the work of planting, cultivating and harvesting over a greater period of time, so that a smaller force of labor can cultivate and care for more crops in the aggregate, than when limited to the short season adapted to *one crop.* The labor of the farm can be utilized to better advantage when a variety of crops is grown, than when but one is planted.

Insects and fungous diseases which prey upon certain crops are

apt to multiply and become serious pests, when the same crop is grown in successive years, upon the same field. A judicious rotation helps to destroy or hold in check those insect enemies and diseases, as the change of crop deprives them of suitable food or conditions of growth, and therefore is often the most economical method of fighting them. We may briefly sum up the advantages of a system of rotation as follows:

1st. It economizes the natural and artificial supplies of plant food in the soil, and helps to enrich the surface soil.

2d. A regular succession of crops, including hoed crops, is of great assistance in keeping the soil free from weeds, insects and fungous diseases.

3d. It economizes the labor of the farm, and is necessary for the satisfactory and profitable feeding of live stock.

4th. By the frequent plowing-in of turf, clover sod and stubble, the mechanical condition of the soil is improved, while the activity of chemical, physical and bacteriological forces is greatly increased, resulting in a greater development of plant food.

Twenty one-tenth acre plots have been devoted to use in six rotations, one of six years, three of five years, one of four years, and one of three years. The establishment of any system of rotation is a question of time, as grass, winter and spring grains and hoed crops cannot all be planted at one time. The right crops can be planted upon certain of the fields and the others brought into rotation as rapidly as possible. The following tables give the rotations planned for those plots, the soil of which is a sandy loam with a subsoil of yellow loam, underlaid with gravel and in poor condition. It is a portion of the field laid out in *permanent plots*, and the numbers refer to the plan in our Fourth Annual Report, page 12.

ROTATION "A."

Plot No.	1893.	1894.	1895.	1896.	1897.	1898.
1	Potatoes.	Rye. Squashes.	Peas. Turnips.	Oats.	Clover.	Potatoes.
3	Squashes.	Peas. Turnips.	Oats.	Clover.	Potatoes.	Rye. Squashes.
5	Turnips.	Oats.	Clover.	Potatoes.	Rye. Squashes.	Peas. Turnips.
7	Oats.	Clover.	Potatoes.	Rye. Squashes.	Peas. Turnips.	Oats.
9	Cow peas.	Potatoes.	Rye. Squashes.	Peas. Turnips.	Oats.	Clover.

This is planned to furnish seven crops in five years, and adapted to the use of dairymen in the vicinity of towns and villages. The rye (winter) is to be cut green for "soiling" or cured for hay or bedding; the ground is then liberally dressed with barnyard manure, ploughed and planted about June 20th to winter squashes as a market crop. The following spring the field is to be planted to early peas. The peas are to be picked for market and the vines utilized as fodder, green or dry, for the farm stock. If care is taken in curing, pea vines make a very palatable and nutritious fodder. A dressing of air slacked lime, three tons per acre, is well worked into the soil before the peas are planted. The peas are picked and the vines removed as early as possible, when the field is planted to white fleshed turnips of the Swede type for market or feeding. A chemical fertilizer containing a good supply of phosphoric acid, used in the drill, is beneficial. The next year oats are sown and also twenty pounds of medium red clover seed per acre. The oats may be allowed to ripen, but if cut green for fodder or cured as oat hay, it will be all the better for the clover crop. After the oats are removed, upon most fields, more or less weeds will grow unless the stand of clover is very perfect. In any case it is an advantage to go over the field with a mowing

machine, having the cutter bar set high enough to clip weeds and heads of clover which are allowed to lie on the ground as mulch. This should be done early enough and often enough to prevent either from ripening seeds. If there are spots in the field where the clover stand is thin or presents an unthrifty appearance, a top dressing of well rotted stable manure very evenly spread will soon improve the growth and bring the spots up to the condition of the remainder of the field, the object being to secure an even and rank growth of clover over the *whole* field. Such care during the autumn, should insure two good crops of clover hay the following summer, and a soil rich in organic matter and nitrogen for the potato crop which follows. The potato crop is fertilized with chemical manures, and after the crop is dug, winter rye is sown and the rotation is again begun. In 1893, all the crops were sown in their order, excepting that peas were omitted from plot No. 5 and cow peas were sown upon plot No. 9, and the crop plowed in as being the nearest approach to clover which could be obtained.

ROTATION "B."

Plot No.	1893.	1894.	1895.	1896.	1897.	1898.
2	Corn.	Potatoes.	Rye.	Clover.	Timothy.	Redtop.
4	Potatoes.	Rye.	Clover.	Timothy.	Redtop.	Corn.
6	Rye,(spring)	Clover.	Timothy.	Redtop.	Corn.	Potatoes.
8	Oats.	Timothy.	Redtop.	Corn.	Potatoes.	Rye.
10	Oats.	Clover.	Corn.	Potatoes.	Rye.	Clover.
12	Rye.(spring)	Corn.	Potatoes.	Rye.	Clover.	Timothy.

This rotation covers a period of six years. The corn crop whenever planted upon plots Nos. 8, 10 and 12, is to be fertilized with stable manure at the rate of eight cords per acre, but upon plots Nos. 2, 4 and 6, it receives a dressing of home mixed chemical manure, equal in money value to the barnyard manure at five dollars per cord. .Chemicals are used upon potatoes and rye, on all the plots alike. The crops obtained from the plots manured entirely with fertilizers will be compared with those grown on plots receiving stable manure once in six years, to see what effect, if any, the stable manure may exert in a rotation. The money value is used as a basis, because it is the standard from which the farmer would work. A dressing of air-slacked lime is applied when the winter rye is sown. Plot No. 2 was planted to corn and No. 4 to potatoes, regular crops in the rotation. No. 6 was sown to spring rye and seeded with red clover, redtop, (*Agrostis vulgaris*,) and timothy, (*Phleum pratense*.) No. 8 was sown with oats, redtop and timothy; No. 10 with oats and clover, and No. 12 with spring rye which was plowed in green. This will bring all the plots, excepting No. 10, into the regular rotation in 1894. The soil being in poor condition, the catch of grass seed has been very imperfect. After this season, the rye will always be winter rye, and the redtop and timothy seed is sown with it in the fall, and the clover seed the following March.

ROTATION "C."

Plot No.	1893.	1894.	1895.	1896.	1897.	1898.
11	Potatoes.	Rye.	Clover.	Potatoes.	Rye.	Clover.
13	Rye.	Clover.	Potatoes.	Rye.	Clover.	Potatoes.
14	Cow peas.	Potatoes.	Rye.	Clover.	Potatoes.	Rye.

This is a short rotation, and similar to that followed by many Western farmers, except that winter rye is sown in place of wheat, which does not thrive well here. Spring rye was sown on plot No. 13, and clover with it. After the potatoes are harvested, air-slacked lime is applied broadcast, and the soil thoroughly harrowed and fitted for seeding to rye; the clover seed is sown, if possible, upon a light snow in the following March. The clover should be well cared for and encouraged to make the best possible growth. *Never "fall-feed" or pasture the young clover after the rye is harvested.* It will invariably weaken the plants and render them liable to winter-killing. Clip the heads off and allow them to lie upon the ground as mulch as directed under rotation A. A liberal amount of fertilizer is used to insure a good potato crop, which is the money crop in this rotation, and the clover sod makes the best possible preparation for it, hence no pains must be spared to have a perfect stand and rank growth of clover.

ROTATION "D."

Plot No.	1893.	1894.	1895.	1896.	1897.	1898.
18	Corn.	Potatoes.	Rye.	Clover.	Corn.	Potatoes.
20	Potatoes.	Rye.	Clover.	Corn.	Potatoes.	Rye.
22	Rye.	Clover.	Corn.	Potatoes.	Rye.	Clover.
24	Cow peas.	Corn.	Potatoes.	Rye.	Clover.	Corn.

This rotation is like C, lengthened one year by the introduction of a corn crop between clover and potatoes. It would be well adapted to a dairy farm where the land was easily cultivated and not adapted to permanent grass. The stable manure would be used on the clover sod for corn, and in a well rotted condition as

top dressing for clover. Lime is applied to the rye and clover seeding as in rotation C. Plots No. 18 and 20 were planted with regular crops of the rotation; plot No. 22 with spring rye and clover, winter rye to be used later in all cases, and No. 24 with cow peas to be plowed in as a substitute for clover.

ROTATION "E."

Plot No.	1893.	1894.	1895.	1896.	1897.	1898.
26	Corn.	Potatoes.	Rye.	Clover and Timothy.	Clover and Timothy.	Corn.
28	Potatoes.	Rye.	Clover and Timothy.	Clover and Timothy.	Corn.	Potatoes.
30	Rye.	Clover and Timothy.	Clover and Timothy.	Corn.	Potatoes.	Rye.
32	Oats and Clover.	Clover and Timothy.	Corn.	Potatoes.	Rye.	Clover and Timothy.
34	Cow peas.	Corn.	Potatoes.	Rye.	Clover and Timothy.	Clover and Timothy.

ROTATION "F."

Plot No.	1893.	1894.	1895.	1896.	1897.	1898.
31	Corn.	Potatoes.	Rye.	Timothy and Redtop.	Timothy and Redtop.	Corn.
33	Potatoes.	Rye.	Timothy and Redtop.	Timothy and Redtop.	Corn.	Potatoes.
35	Rye.	Timothy and Redtop.	Timothy and Redtop.	Corn.	Potatoes.	Rye.
37	Oats.	Timothy and Redtop.	Corn.	Potatoes.	Rye.	Timothy and Redtop.
39	Buckwheat.	Corn.	Potatoes.	Rye.	Timothy and Redtop.	Timothy and Redtop.

These two rotations are duplicates except that E includes *clover* with the crops grown and F does not, the object being to compare the results of the two rotations. In rotation E plots No. 26 and 28 were planted with the regular crops; No. 30 to spring rye, clover and timothy; No. 32 with oats and clover, and No. 34 with cow peas to plow under. In rotation F, Nos. 31 and 33 were planted with the regular crops; No. 35 with spring rye, timothy and redtop; No. 37 with oats, timothy and redtop, and No. 39 with buckwheat for plowing under. Buckwheat was used instead of cow peas in order that no leguminous plants be grown upon any plot belonging in this rotation.

As this is the first year of planting, and the rotations not yet in full force, records of crops are omitted.

EXPERIMENTS WITH LEGUMINOUS PLANTS.

The trial of legumes was made upon three of our most uniform and thoroughly exhausted plots of the experiment land on the plain. The object, aside from studying the habits and growth of the most common leguminous plants, was to determine the effects of different applications of nitrogen. The three plots (permanently numbered 17, 19 and 21) each received an application of 1,200 pounds dissolved South Carolina Rock (16.63 per cent. total phosphoric acid), and 180 pounds muriate of potash (50 per cent. potassium oxide), while in addition No. 19 received 150 pounds of nitrate of soda (15.50 per cent. nitrogen), and No. 21 received 450 pounds of nitrate of soda of the same strength, while no nitrogen whatever was applied to No. 17.

Seed of the following thirty-two legumes was sown May 29, in duplicate rows, three feet apart across each of the three plots. Common red, mammoth red, white, alsike and crimson clovers made fair growth, with but slight differences in favor of the nitrogen plots. No crop was harvested as the plants are to remain a second year.

Alfalfa and Bokhara clover succeeded better where nitrogen was applied, though the larger application of nitrogen gave no perceptible increase in yield. The roots of these plants grew especially deep on the plot where the nitrogen was applied.

The English horse bean did not mature and was so badly eaten by an insect (blister beetle) that no conclusions could be drawn from its growth and behavior.

Kidney vetch or sand clover and sainfoin (Onobrychis Sativa) being biennials were not weighed this year; but slight differences were noticed in their growth in the three plots.

The results of the remaining crops may best be seen by studying the following:

TABLE GIVING WEIGHTS OF SHORT ROWS AND COMPUTED YIELDS PER ACRE.

	WEIGHTS OF 24 FT. OF ROW.				COMPUTED YIELD PER ACRE.		
	Condition when weighed.	Plot 17, Receiving no Nitrogen.	Plot 19, Receiving 150 lbs. N. Soda per Acre.	Plot 21, Receiving 450 lbs. N. Soda per Acre.	Plot 17.	Plot 19.	Plot 21.
		lbs.—oz.	lbs.—oz.	lbs.—oz.	lbs.—oz.	lbs.—oz.	lbs.—oz.
Granger Peas...	Air-dry	2—11	3—8	4—1	1625—15	2117—8	2457—13
Stratagem Peas......	"	2—8	5—2	4—14	1512—8	3100—10	2949—6
Cow Peas................	Green..	6—10	7—14	6—2	4008—2	4764—6	3705—10
Soja Bean................	"	3—6	5—2	5—2	2041—14	3100—10	3100—10
Medium Green Soja Bean.	"	9—8	11—8	7—10	5747—8	6957—8	4613—2
Medium Black Soja Bean.	"	10—0	11—12	7—4	6050—0	7108—12	4386—4
Early White Soja Bean...	"	3—2	4—6	3—8	1890—10	2646—14	2117—8
Yamagata-cha Daidzu....	"	7—8	8—2	4—6	4537—8	4915—10	2646—14
Kiyusuke Daidzu	"	9—8	12—8	8—14	5747—8	7562—8	5369—6
Edamame.....	"	6—4	5—10	5—14	3781—4	3403—2	3554—6
Yellow Soy....	"	3—10	6—6	5—8	2193—2	3856—14	3327—8
Black Podded Adzuki ...	"	5—2	8—10	6—4	3100—10	5218—2	3781—4
White Podded Adzuki. ..	"	7—8	9—4	9—0	4537—8	5596—4	5445—0
Spring Vetch............	"	5—10	8—0	6—0	3403—2	4840—0	3630—0
White Lupine........ ...	"	14—4	13—12	22—8	8621—4	8318—12	13612—8
Blue Lupine.....	"	6—8	8—10	9—8	3932—8	5218—14	5747—8
Yellow Lupine.	"	27—8	30—0	39—4	16637—8	18150—0	23746—4
*Golden Wax Beans.	....	—6	—11½	—13	226—14	434—13¾	491—9
White Beans.....	Air-dry	4—2	6—2	7—9	2495—10	3705—10	4575—5
Serradella................	Green..	23—0	29—4	25—8	13915—0	17696—4	15427—8
Spurry.	"	6—12	8—4	6—2	4083—12	4991—4	3705—10

* Weight of threshed beans only.

Because of the fact that all leguminous plants are able to obtain a portion of the nitrogen necessary for their growth from the atmosphere, the cultivation of as many of them as possible for

fodder or green manuring is important to the farmer. In our last report (Fifth Annual Report, page 150) we called attention to the merits of the varieties of the soja or soya bean and cow pea as fodder crops especially valuable to the dairy man for summer feeding, soiling and for ensilage. They are tender plants and can only be sown when all danger of frost is past and must be harvested before frost in the fall, therefore there season of usefulness is somewhat limited. The farmer with a large herd of milch cows and limited pasture desires an abundant crop for soiling early in spring and late in autumn. We can find such among the leguminous plants. The Canada field pea sown with oats or barley early in the spring makes an excellent fodder. Sow two bushels per acre and plow in about four inches deep, then sow two bushels of oats, harrow thoroughly and roll. If stable manure is applied it should be spread before peas are sown and plowed in; fertilizer or chemicals may be sown broadcast after the peas are plowed in. It will then be well worked into the soil by the harrow with the oats. The crop can be cut and fed green, or cut when the oats are in milk and well cured it makes a palatable and valuable fodder. Some dairymen prefer to sow three bushels of peas and one of oats. The fodder of such a mixture will be richer in nitrogenous elements than when the proportion of oats is larger. We believe that the Canada pea is worthy of much more extended cultivation as a fodder crop, especially for early spring and late fall use.

Serradella (Ornithopus-sativus) is a fodder crop of some promise. The yield in a green state as seen by the table was between seven and eight tons. At the Massachusetts State Experiment Station the yield has reached as high as thirteen and a half tons of green fodder. It has been used for feeding with excellent satisfaction. It is a low growing annual leguminous plant. The seed is greenish brown in color, about an eighth of an inch long, a trifle less wide and in thickness about one-fourth the length. It may be sown quite early in the spring and grows until the severe frosts of late fall kill it.

Spurry (Spergula arvensis). This is a very low growing annual leguminous plant with fine stems. The seed is about the size of alsike clover seed but black in color. It germinates quickly in a warm soil and grows rapidly so that two or three crops can be grown in a season. The seed ripens early and shells easily so that a second crop will often grow from self sown seed. It seems to prefer sandy soil and on the "pine barrens" or "jack-pine" lands of Michigan it has been grown for several years with excellent results. It grows wild in Great Britain and is there regarded as a weed, but in Germany and France it is sown after other crops and used as a winter pasture for cattle, sheep and hogs. Some authorities regard it as better than clover. Hens are said to be very fond of it either in a green or dry condition. We think caution should be used in sowing it upon rich land as it may easily become a weed. Upon sandy pastures it would, perhaps, be of value in filling up the vacancies in the sward and improving the quality of the herbage. As a "catch crop" after spring grains or early potatoes it would furnish excellent food for cattle or sheep or a good crop to plow under for green manuring.

LIME AND CLOVER.

In our Fifth Annual Report, page 136, is an account of a fertilizer experiment with oats upon nine one-fourth acre plots located upon the plain east of the barn. Seaweed at the rate of nine one-seventh cords per acre was applied broadcast in 1891, and in the following spring (1892) the north half of all the plots received a broadcast dressing of 1,776 pounds of air-slacked lime per acre and the field was seeded with oats and clover. The season proved a poor one for oats and the yield was small, but from the table given in that report, page 137, we found that the lime increased the yield of grain 22 per cent. and the yield of straw nearly 28 per cent., and the clover, after the oats were harvested, showed a much thicker stand and more vigorous growth upon the limed portion of the field. In 1893 the superiority of the clover upon

the north half of the field which has received the dressing of lime the previous year was manifest during the entire season. The first crop was cut July 1st and weighed July 5th. The second crop was cut August 21st and weighed August 26th. The weights are as follows:

	First crop. Pounds.	Second crop. Pounds.	Total.
North half, limed..........	2,830	2,205	5,035
South half, unlimed........	1,960	1,790	3,750
Increase by liming......	870	415	1,285

The yield of both crops on the limed portion was at the rate of 4,475 pounds per acre or about 2¼ tons, while that on the unlimed portion was 3,333 pounds or 1⅝ tons per acre. The gain by liming being 34 per cent.

POTATOES.

Small lots of each of the following varieties of potatoes were planted for a test of comparative yield. The seed tubers were carefully weighed and cut as far as practicable to single eye pieces, the number of which is given in the second column.

The fertilizer applied was home mixed, and two-thirds of the quantity was spread broadcast and harrowed in; the other third was applied in the drill at time of planting.

FORMULA B.

	Pounds per acre.
Nitrate of Soda..	105
Tankage..	750
S. C. Bone..	540
Fine Ground Bone..	120
Muriate of Potash	300
	1,815

The table gives the yields of tubers, all under two ounces in weight being classed as small.

NAME OF VARIETY.	Weight of seed tuber in ounces.	Number of pieces.	Length of row in feet.	YIELD IN POUNDS. Weight of large tubers.	Weight of small tubers.	Total weight.	Product per ounce of seed tubers.
Beauty of Hebron........	16.75	30	45.00	29.50	5.50	35.00	2.09
Chas. Downing...........	17.25	27	40.50	25.50	6.00	31.50	1.83
Early Maine.............	16.50	29	43.50	37.50	3.00	40.50	2.09
Early Ohio..............	17.25	29	43.50	15.75	4.50	20.25	1.17
Early Puritan...........	17.25	32	48.00	28.00	6.75	34.75	2.01
Early Rose....	16.75	30	45.00	31.00	5.12	36.12	2.15
Empire State.......	16.50	29	43.50	41.75	3.25	45.00	2.73
Freeman.................	16.50	27	39.75	30.13	4.62	34.75	2.10
Monroe Seedling.....	17.50	26	39.00	22.50	3.50	26.00	1.48
New Early Sunrise.......	18.50	28	42.00	38.00	8.25	46.25	2.50
New Early White Prize..	18.25	29	43.50	28.50	3.25	31.75	1.74
Polaris.................	18.25	34	51.00	30.00	6.50	36.50	2.00
Prince E. Is. Rose........	16.75	29	43.50	27.50	7.00	34.50	2.06
Rose Beauty of Beauties.	16.75	23	34.50	23.00	3.00	26.00	1.55
White Star..............	17.	22	33.00	26.00	3.50	29.50	1.74

CO-OPERATIVE FIELD EXPERIMENTS WITH FERTILIZERS ON INDIAN CORN. FOURTH YEAR.

J. D. TOWAR.

During the past season only three experiments have been continued in this line. One upon the farm of Mr. Herbert E. Lewis in the town of Exeter, one upon the farm of E. F. Crowninshield, town of Cumberland, and another upon the Experiment Station Farm at Kingston.

The dried blood used this year was lower than usual in per cent. of nitrogen, and the quantity was slightly increased, with that exception, as will be seen by the following tables, no change was made in the amounts of fertilizers applied, but in addition to the nitrogen, phosphoric acid and potash upon plots 7—00 inclusive, there was applied to one-third of each, 84 lbs. of air slacked lime or an application of 2½ tons per acre. The results of this lime experiment are given on subsequent pages of this report.

The fertilizing materials cost on board the cars at Pawtucket as follows:

Nitrate of Soda	$50.00	per ton.
Sulphate of Ammonia	75.00	"
Dried Blood	45.00	"
Muriate of Potash	47.00	"
Dissolved Boneblack	26.00	"

Samples of the above were analyzed by the Station chemists with the following results:

ANALYSES OF FERTILIZING MATERIALS.

NITROGEN

Sulphate of Ammonia	20.00	per cent.
Nitrate of Soda	15.50	"
Dried Blood	8.60	"

POTASSIUM OXIDE.

Muriate of Potash	50.65 per cent.

PHOSPHORIC ACID.

Dissolved Boneblack,	Soluble	15.49	per cent.
" "	Reverted	.09	"
" "	Insoluble	.00	"
Total		15.58	"

From the above prices and analyses of these materials, the cost of the three elements, nitrogen, potash and phosphoric acid is found to be as follows:

Nitrogen in Nitrate of Soda	16.13	cents per lb.
" Dried Blood*	26.00	" "
" Sulphate of Ammonia	18.75	" "
Potash (Potassum Oxide) in Muriate	4.74	" "
Phosphoric Acid in Dissolved Boneblack	8.37	" "

* Value of phosphoric acid deducted.

PLAN OF EXPERIMENTAL FIELDS.

Showing the arrangements of plots and the kind and amount of fertilizers applied. Twenty plots, each plot one-twentieth of an acre. Where possible, unmanured strips were left between the plots.

The area within the dotted lines received air-slaked lime at the rate of two and one-half tons per acre.

0.	No Manure.
1.	Nitrate of Soda, 24 lbs.
2.	Dissolved Boneblack, 30 lbs.
3.	Muriate of Potash, 10 lbs.
4.	Nitrate of Soda, 24 lbs.; Dissolved Boneblack, 30 lbs.
5.	Nitrate of Soda, 24 lbs.; Muriate of Potash, 10 lbs.
6.	Dissolved Boneblack, 30 lbs.; Muriate of Potash, 10 lbs. "Mixed Minerals."
7.	Mixed Minerals as No. 6, plus Nitrate of Soda, 8 lbs., $\frac{1}{3}$ Ration.
8.	Mixed Minerals as No. 6, plus Nitrate of Soda, 16 lbs., $\frac{2}{3}$ Ration.
9.	Mixed Minerals as No. 6, plus Nitrate of Soda, 24 lbs. full Ration.
6*a*.	Mixed Minerals. Duplicate of No. 6.
10.	Mixed Minerals as No. 6, plus Sulphate of Ammonia, 6 lbs., $\frac{1}{3}$ Ration.
11.	Mixed Minerals as No. 6, plus Sulphate of Ammonia, 12 lbs., $\frac{2}{3}$ Ration.
12.	Mixed Minerals as No. 6, plus Sulphate of Ammonia, 18 lbs. full Ration.
6*b*.	Mixed Minerals. Duplicate of No. 6.
13.	Mixed Minerals as No. 6, plus Dried Blood 13 lbs., $\frac{1}{3}$ Ration.
14.	Mixed Minerals as No. 6, plus Dried Blood 26 lbs., $\frac{2}{3}$ Ration.
15.	Mixed Minerals as No. 6, plus Dried Blood 39 lbs., full Ration.
6*c*.	Mixed Minerals. Duplicate of No. 6.
00.	No Manure.

TABLE SHOWING THE WEIGHT AND COST OF FERTILIZERS.

No. of Plot.	Weight per Plot.	KIND OF FERTILIZER.	Weight Per Acre.	Nitrogen Per Acre.	Actual Potash per Acre.	Total Phosphoric Acid per Acre.	*Cost per Acre.
	lbs.		lbs.	lbs.	lbs.	lbs.	
0.	0.0	Nothing	....	....	....	......	......
1.	24.0	Nitrate of Soda	480	74.40	....	......	$12 00
2.	30.0	Dissolved Boneblack	600	....	...	93.18	7 80
3.	10.0	Muriate of Potash	200	....	101.3	......	4 80
4.	24.0 30.0	Nitrate of Soda .... 480 Dissolved Boneblack 600	1080	....	....	93.18	19 80
5.	24.0 10.0	Nitrate of Soda .... 480 Muriate of Potash 200	680	....	101.3	......	16 80
6.	30.0 10.0	Dis. Boneblack } Mixed } .... 600 Mur. of Potash } Minerals } 200	800	....	101.3	93.18	12 60
		NITRATE OF SODA GROUP.					
7.	40.0 8.0	Mixed Minerals as No. 6 .... 800 Nitrate of Soda, ⅓ Ration 160	960	24 80	101.3	93.18	16 60
8.	40.0 16.0	Mixed Minerals as No. 6 .... 800 Nitrate of Soda, ⅔ Ration 320	1120	49.60	101.3	93.18	20 60
9.	40.0 24.0	Mixed Minerals as No. 6 .... 800 Nitrate of Soda, full Ration 480	1280	74.40	101.3	93.18	24 60
6a.	40.0	Mixed Minerals as No. 6	800	....	101.3	93.18	12 60
		SULPHATE OF AMMONIA GROUP.					
10.	40.0 6.0	Mixed Minerals as No. 6 .... 800 Sulph. of Ammonia, ⅓ Ration ... 120	920	24.00	101.3	93.18	17 10
11.	40.0 12.0	Mixed Minerals as No. 6 .... 800 Sulph. of Ammonia, ⅔ Ration ... 240	1040	48.00	101.3	93.18	21 60
12.	40.0 18.0	Mixed Minerals as No. 6 ..... 800 Sulph. of Ammonia, full ration, 360	1160	72 00	101.3	93.18	26 10
6b.	40.0	Mixed Minerals as No. 6	800	....	101.3	93.18	12 60
		DRIED BLOOD GROUP.					
13.	40.0 13.0	Mixed Minerals as No. 6 .... 800 Dried Blood, ⅓ Ration 260	1060	22.36	101.3	93.18	18 45
14.	40.0 26.0	Mixed Minerals as No. 6 .... 800 Dried Blood, ⅔ Ration 520	1320	44.72	101.3	93.18	24 30
15.	40.0 39.0	Mixed Minerals as No. 6 .... 800 Dried Blood, full Ration 780	1580	67.08	101.3	93.18	30 15
6c.	40.0	Mixed Minerals as No. 6	800	....	101.3	93.18	12 60
00.	00.0	Nothing	....	....	...	......	......

* Not including freight.

The objects of these experiments have been already enumerated in three former reports. They are in brief to answer the following questions:

1. What does the soil need?

2. What will be the action of various forms and quantities of nitrogen upon the Indian corn crop?

3. If in a single experiment one element is found lacking, does it necessarily follow that that element will be found most deficient if the experiment is carried on several years in succession?

4. What will be the result of one-sided plant feeding after a period of years?

The following tables give the yields of hard corn, soft corn and stover in pounds per acre for the past four years, taken in part from the three former reports and include the results of the past year's experiments. An average of the yields for the past three years is also given. The results of the first year's experiment were left out in obtaining the averages, from the fact that the available plant food in the soil at the time the experiment was begun, very materially affected the results and served to mislead one in drawing conclusions.

KINGSTON EXPERIMENT.

Table showing the yields in pounds of hard corn, soft corn and stover for the four years in which the experiment was conducted, also the average of the yields for the last three years.

No. of Plot.	1890.			1891.			1892.			1893.			Average last 3 Years.		
	Hard.	Soft.	Stover.	Hard.	Soft.	Stover.	Hard.	Soft.	Stover.	Hard.	Soft.	Stover.	Hard.	Soft.	Stover.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
0	1700	200	1400	230	155	515	70	230	600	00	47	369	100	144	495
1	1700	250	1650	390	235	575	70	370	760	00	42	321	153	216	552
2	2000	200	2000	1005	415	1160	490	670	1440	36	225	1174	510	437	1258
3	3100	75	2700	905	300	945	60	380	780	00	32	895	322	237	707
4	2600	225	2660	910	550	1330	1535	775	1790	355	284	1695	933	536	1608
5	2900	100	2650	855	330	1065	115	520	1125	00	46	719	323	299	986
6	3150	75	2650	1540	245	1870	1735	690	2175	370	365	1842	1215	433	1796
7	2950	125	2550	2150	240	1695	2630	410	2560	658	398	2400	1811	349	2218
8	3150	100	2500	2620	185	2040	3200	330	3230	1061	331	2606	2294	265	2625
9	3650	100	3500	2875	180	2560	3590	315	3795	915	278	2482	2460	258	2946
6a	4300	150	3400	2690	105	2125	2145	405	2150	399	158	2005	1745	228	2093
10	3560	125	3000	2295	105	1840	2140	494	2433	464	309	1940	1683	303	2071
11	1950	200	1500	1085	150	1140	500	326	907	177	101	984	587	192	1010
12	1100	200	1300	895	160	825	314	360	1193	85	142	624	431	221	881
6b	2750	225	2400	1830	130	1229	2305	680	2725	630	270	2250	1588	343	2090
13	2400	150	1750	2385	110	1965	2400	600	2660	671	264	2231	1819	325	2285
14	2700	100	2100	2715	60	1895	2520	660	3520	780	225	2295	2005	315	2670
15	2400	250	1700	1930	235	1610	2195	660	2645	663	271	2080	1596	298	2112
6c	1400	200	1600	2240	165	1780	1665	825	2050	630	240	1980	1512	410	1937
00	500	225	800	83	62	240	000	110	830	00	58	327	28	75	299

ABBOTT RUN EXPERIMENT.

Table showing the yields in pounds of hard corn, soft corn and stover for the four years in which the experiment was conducted, also the average of the yields for the last three years.

No. of Plot.	1890.			1891.			1892.			1893.			Average last 3 Years.		
	Hard.	Soft.	Stover.	Hard.	Soft.	Stover.	Hard.	Soft.	Stover.	Hard.	Soft.	Stover.	Hard.	Soft.	Stover.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
0	1000	300	700	190	130	680	30	120	550	20	60	260	80	103	497
1	2300	150	1100	1440	100	1300	280	530	1190	260	270	670	660	300	1053
2	2200	150	1050	1430	60	2010	595	480	1825	960	280	960	962	273	1598
3	2100	100	1000	980	120	1700	380	660	1260	250	280	670	537	353	1210
4	2350	150	1050	2000	50	2170	2150	250	2500	2150	100	1550	2100	133	2073
5	1700	100	900	860	160	1680	320	540	1440	400	200	800	527	300	1307
6	2400	100	1100	1760	120	2020	740	310	2455	980	240	1280	1160	223	1918
7	2500	75	1200	2400	120	2380	2430	185	3085	2000	120	1780	2277	142	2415
8	2600	100	1100	2360	120	2820	2740	170	3490	2680	85	2235	2593	125	2848
9	2900	150	1200	2520	80	2800	2850	155	3495	2925	120	2255	2765	118	2850
6a	1750	175	900	640	140	2280	510	330	2660	745	280	1375	632	250	2105
10	1650	300	850	700	160	1940	1440	330	2730	780	365	1455	940	285	2042
11	1400	350	900	1820	140	2240	1685	365	2050	945	300	1355	1483	268	1882
12	2100	300	1200	1080	200	2820	2030	340	2430	1335	250	1415	1482	263	2222
6b	1500	150	1100	640	160	2500	700	130	2770	340	190	1070	560	160	2113
13	1600	150	1100	1040	170	2590	1260	130	3010	840	200	1560	1047	167	2387
14	1500	175	1150	1420	200	2580	1760	150	3290	1310	160	1730	1497	170	2533
15	2100	150	1050	1980	160	2860	1980	175	3245	1880	150	2070	1947	162	2725
6c	1050	75	1100	540	200	2460	370	205	2425	230	150	1220	380	185	2035
00	1100	100	750	540	200	1460	135	400	1165	140	260	600	272	287	1075

HOPE VALLEY EXPERIMENT.

Table showing the yields in pounds of hard corn, soft corn and stover for the four years in which the experiment was conducted, also the average of the yields for the last three years.

No. of Plot.	1890.			1891.			1892.			1893.			Average last 3 Years.		
	Hard.	Soft.	Stover.	Hard.	Soft.	Stover.	Hard.	Soft.	Stover.	Hard.	Soft.	Stover.	Hard.	Soft.	Stover.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
0	1500	325	1450	820	80	1100	64	260	667	00	81	284	295	140	684
1	1475	425	1775	680	160	1050	80	260	654	20	81	376	260	167	693
2	1550	200	1575	1300	90	1700	334	460	1076	83	32	790	572	194	1189
3	1150	250	1625	1140	100	1200	270	470	834	25	236	673	478	269	902
4	2550	275	2500	2900	70	2175	1544	430	1473	1538	493	1367	1994	331	1672
5	1400	250	2025	1480	90	1275	200	364	930	108	216	636	596	223	947
6	1950	350	2400	2010	70	2000	770	330	1495	275	420	1100	1018	273	1532
7	2350	275	2675	3220	85	2400	1684	384	2217	1584	281	1672	2163	250	2096
8	3350	375	3975	3680	120	2550	2500	224	2942	2338	237	2190	2839	197	2561
9	2350	325	3050	4240	200	3175	2440	200	2366	2295	251	2128	2986	217	2556
6a	1825	275	2275	2200	60	2150	660	324	1673	370	370	1184	1077	251	1669
10	3375	425	3500	2040	30	2000	1660	180	2050	997	420	1725	1566	210	1925
11	4200	400	4325	3560	40	2600	950	450	1449	365	280	1322	1625	257	1790
12	3600	350	3600	2640	55	2100	1250	534	2035	680	194	1021	1523	261	1719
6b	2350	225	2700	2020	80	1900	730	260	1673	264	181	1148	1005	174	1574
13	3150	225	2850	2980	65	2050	1564	290	2242	966	332	1691	1837	229	1994
14	2625	325	2900	3385	110	3100	2034	304	2570	1561	311	2250	2327	242	2640
15	2875	325	2900	3780	85	2900	1870	320	2423	1524	326	2279	2391	244	2534
6c	1675	250	2100	2465	130	2300	754	434	1708	392	192	1154	1204	252	1721
00	1600	550	1850	1220	110	1050	170	454	755	40	119	348	477	228	718

GENERAL CONCLUSIONS.

1st. *What does the soil need?*

Looking at the yields from plots 0 and 00 upon which no plant food has been applied during the past four years, it is evident that the soil needs *something*. Again, looking at plot 1, upon which an amount of nitrate of soda varying in quantity from 150 to 480 lbs. per acre has been annually applied for the past four years it appears to be quite efficient in the Abbott Run experiment, slightly in the Kingston, while in the Hope Valley experiment it has shown no beneficial effects whatever. On plot 2, where dissolved bone-black alone has been applied each year, the yield is much larger than on 1, 3 or 5 where potash and nitrogen were applied, thus testifying that phosphoric acid is much needed *as a single element in every case.* It has produced larger yields than either nitrogen or potash.

Upon examining the yields from plots 4, 5 and 6 to determine the most efficient combination of the elements we find in the Abbott Run and Hope Valley experiments that nitrogen and phosphoric acid (plot 4) gave the better results, while in the Kingston experiment (plots 6, 6a, 6b and 6c) phosphoric acid and potash produced better yields.

2d. *What will be the action of various forms and quantities of nitrogen upon the Indian corn crop?*

We must notice plots 7—6c inclusive. Here we find the yields from the use of nitrate of soda much superior and more profitable than those from the use of the other materials, while dried blood has given better results than sulphate of ammonia.

The quantity of nitrogen best adapted to the growing of Indian corn was tested by using one-third rations (plots 7, 10 and 13), two-third rations (plots 8, 11 and 14), and full rations (plots 9, 12 and 15). There is a profitable increase in yield in two-third ration plots over one-third rations, while the average increase in yield of

Plot 2.
Phosphoric Acid.

Plot 1.
Nitrogen.

Plot 0. No manure.

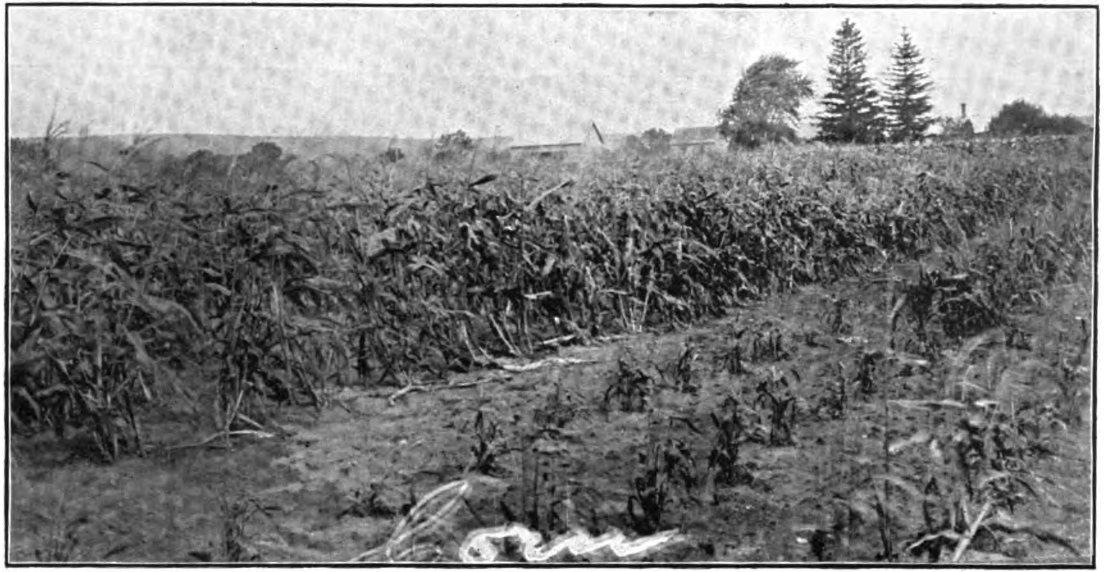
FIG. A.

Plot 4.
Phosphoric Acid
and
Nitrogen.

Plot 3. Potash.

FIG. B.

Plot 6.
Phosphoric Acid
and
Potash.



Plot 5. Potash and Nitrogen.

FIG. C.

full ration over two-third rations is no more than sufficient to pay for the extra amount of fertilizer applied. As the amount of potash and phosphoric acid remained the same in the various rations, the full ration plots may have lacked in these two or some other elements allowing the extra supply of nitrogen to go to waste. From this we may conclude that for the corn crop the one-third rations did not contain enough nitrogen, the two-third rations were the best balanced manures, and that in the full rations some of the added nitrogen was unprofitable.

3d. *If in a single experiment one element is found lacking, does it necessarily follow that that element will be found most deficient if the experiment is carried on several years in succession?*

This question is readily answered by comparing the relative yields from the 1890 experiment with the average yields from the last three years of the experiment where it will be found that the relative yields in 1890, especially in the single and double element plots differ greatly from those of the average of the later years.

4th. *What will be the result of one-sided plant feeding after a period of years?*

The answer to this question may be found by noticing the gradual falling off in yields of the single and double element plots (1—6), also in the one-third ration plots 7, 10 and 13 where the supply of nitrogen was insufficient to balance the potash and phosphoric acid applied.

In the last two years of the experiment the amount of nitrogen upon plots 1, 4 and 5 was increased from 160 pounds to 480 pounds per acre, equal to the full ration as applied on plot 9. This was done with a view to insure a supply of nitrogen sufficient to give the best possible results. The yields from these plots show no variation that could be attributed to the increased application of nitrogen.

ON THE OCCASIONAL ILL-EFFECT OF SULPHATE OF AMMONIA AS A MANURE AND THE USE OF AIR-SLACKED LIME IN OVERCOMING THE SAME.

H. J. WHEELER AND J. D. TOWAR.

The number of field, pot and water-culture experiments conducted with sulphate of ammonia is already great and an attempt to enumerate all of them is not only impracticable here, but foreign to our purpose. It is our object at the outstart to show that nitrogen in the form of sulphate of ammonia has been found at times and with certain soils and crops to give results equal to or superior to that in form of nitrate of soda, and that under other circumstances it has proved positively harmful. In fact all degrees of results between these two extremes have been obtained.

The injurious action of sulphate of ammonia in experiments by way of water culture and on plants grown in artificially prepared soils, has been frequently noted.[1] The conditions under which these experiments were conducted, however, are not those naturally met with, and we shall therefore confine ourselves for the present more particularly to a consideration of the results of actual field experiments, or experiments with natural soils.

RESULTS SHOWING THE MANURIAL VALUE OF NITROGEN IN FORM OF SULPHATE OF AMMONIA, COMPARED WITH THAT IN NITRATE OF SODA.

A. Stutzer[2] gives a tabulated summary of 450 experiments with rye, oats, wheat, barley, potatoes, sugar beets, grass and fodder-beets, with nitrogen in form of sulphate of ammonia and nitrate of

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[1] Storer, Agriculture, Vol. I, Chap. XII, New York, 1889: Johnson, How Crops Feed, New York, 1891, pp. 300-305.

[2] Der Chilisalpeter, Berlin, 1886, pp. 97 and 98.

soda. From a study of the results, the greater value of nitrogen in the form of nitrate of soda is, in the majority of cases, extremely marked; this being especially true in regard to sugar beets. It is evident, however, as before stated, that nitrogen as sulphate of ammonia has given results showing all gradations from good to bad.

In experiments with potatoes, P. Wagner[1] has noted a positively injurious effect of sulphate of ammonia, which lasted for a time only, for the plants recovered later and grew well, though the final yield was less upon the sulphate of ammonia plots than where no nitrogen had been applied. A decided increase in yield was obtained by the use of nitrogen in form of nitrate of soda. He states that the cause of this ill-effect is not known, and that "it remains for further experiments to throw light upon this practical and very important question."

Dehérain[2] found, upon the farm of the Experiment Station at Grignon, France, that large applications of sulphate of ammonia exerted a highly injurious influence upon the vegetation and that in smaller quantities the results, though less marked, were similar. During 1876 and 1877 the yield of sugar beets was less in every case where sulphate of ammonia was employed alone or in combination with superphosphate, than where no manure was applied. The injurious after-effect of the sulphate of ammonia was very marked upon crops of sainfoin in 1878 and 1879 as well as upon crops of cereals grown in 1880, 1881 and 1882. It is stated that the reason for this ill-effect must still be ascertained. It is worthy of note that each additional application of nitrogen in the form of nitrate of soda was accompanied by an increased yield.

Bæssler,[3] in experiments with potatoes on a sandy soil, found that nitrogen in form of nitrate of soda, if not used in too great quantities, was profitable. In the case of sulphate of ammonia,

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[1] Düngungsfragen, Berlin, 1887, pp. 50–52.

[2] Jahresbericht f. Agrikulturchemie, 1883, p. 243, Neue Zeit. f. Rübenzucker-Industrie, 1883, Bd: II, No. 2, p. 14, and Biedermann's Central-Blatt, 1883, p. 593.

[3] Jahresb. f. Agrikulturchemie, 1888, p. 309.

however, the cost of the fertilizer was not recovered, and he concludes that for potatoes, on sandy soil, nitrogen in the latter form is uncertain in its effect and is not able to compete with the more reliable nitrate of soda.

In comparative tests with nitrogen in form of nitrate of soda and sulphate of ammonia, conducted by Klein[1] at Nodems and Losgehnen, the value of nitrogen in the two forms was practically the same but in experiments at Neuhof the ill-effect of sulphate of ammonia was extremely marked. The crop experimented upon was oats, and the yields of grain were as follows:

7½ lbs. of nitrogen as sulphate of ammonia	1,380 lbs.
10 " " " " " " "	1,140 "
15 " " " " " " "	880 "
20 " " " " " " "	[illegible]00 "

The results with nitrate of soda secured on the same soil stand in strong contrast to those just given, for by each addition of nitrogen in this form, the yield was decidedly increased; 7½ lbs. of nitrogen producing 1,400 lbs. of grain; and 15 lbs., 1,520 lbs. of grain.

Birnbaum[2] states, in case of spring applications, that if, due to drought or other causes, the amount of sulphate of ammonia is not nitrified or changed to nitric acid in the soil, it has a directly injurious action upon the young plants.

Huston,[3] in experiments on wheat found that like amounts of nitrogen in form of nitrate of soda and sulphate of ammonia were not equally effective, and that the former gave a much greater gain of both grain and straw. Superphosphate and muriate of potash were used in connection with the nitrogen in each case. The soil was a "dark clay loam containing considerable sand and rested upon gravel."

Sebelein,[4] in pot experiments with barley, grown in loam, found

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[1] Biedermann's Central-Blatt, 17, p. 167.

[2] Der Zuckerrübenbau, Breslau, 1867, p. 67.

[3] Agricultural Science, Vol. 5, No. 8, p. 195.

[4] Norsk Landmansblad, 1891, Nos. 23-24. S. 253-255 u. S. 266-268 and Biedermann's Central-Blatt, 1892 p. 809.

that the nitrogen of sulphate of ammonia gave a poor showing compared with that in form of nitrate of soda, and he further refers to experiments by Magerstein, Mach, Rolland and others, in which similar results were obtained. The data obtained by Lawes and Gilbert,[1] of Rothamstead, in experiments with several crops extending over a long period of years show that the results obtained with nitrate of soda were superior to those with sulphate of ammonia. At Woburn, however, the comparative results obtained with sulphate of ammonia are, in general, much better than at Rothamstead.[2]

Experiments by Heinrich,[3] with rye, upon sandy soil, in two different locations, show that the relative value of nitrogen in form of nitrate of soda and sulphate of ammonia varied decidedly upon the soils in question, and that in one case the yield from the sulphate of ammonia fell far behind that from the nitrate of soda. Results by Samek[4] show, likewise, the inferiority of sulphate of ammonia in experiments with beets (Runkelrüben). In special nitrogen experiments on grass,[5] Woods and Phelps found for both forms of nitrogen practically the same results in 1891, though in 1892 that in form of nitrate of soda gave somewhat better results than sulphate of ammonia. In these experiments the nitrogen was applied in connection with superphosphate and potash.

P. Wagner and Dorsch[6] have shown by plot and pot experiments that nitrogen in form of nitrate of soda gave greater returns than in form of sulphate of ammonia. An average of their pot experiments showed that if the effect of the nitrogen in the nitrate be set at 100 that of the sulphate of ammonia would be represented by about 90. They also note that sulphate of ammonia gives poorer results with barley than with wheat, rye or oats.[1] The

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[1] Journal Royal Agr'l Society, 1884, p. 447.

[2] Journal Royal Agr'l Society, 1877 to 1888.

[3] Landw. Annalen d. mecklenb. patriot. Ver., 1887, No. 49, p. 385, cited from Bretfeld Pflanzenphysiologie, p. 183.

[4] Tyroler landw. Blätter, 7 Jahrg., 1889, No. 2, S. 14-15, abstract in Biedermann's Central-Blatt, No. 19, 1889, p. 282.

[5] 4th Annual Report, Storr's School Agr'l Exp't Sta., Conn., 1891, p. 29.

[6] Die Stickstoffdüngung der landw. Kulturpflanzen, Berlin, 1892, p. 197.

same authors have also given an average deduced from the table referred to on page 206, which shows that 100 kilos of nitrate of soda have raised the yield above that of an equivalent amount of sulphate of ammonia, as follows:

25	kilos	more	of	wheat (grain).
57	"	"	"	barley "
164	"	"	"	potatoes.
920	"	"	"	sugar beets.
1,739	"	"	"	fodder beets (Futterrüben).

It would appear from this that for some reason the sulphate of ammonia was less efficient for beets than for the other crops. After this brief review of results secured in the comparison of the two forms of nitrogen it is of interest to note a statement by Mærcker,[2] to the effect that the claimed injurious effect of ammonia salts is not proved and certainly does not occur on soils in normal condition. What the above mentioned writer considers the normal condition of a soil to be is not easy to determine. If he means a soil provided with an abundance of all the elements essential to plant growth, it might be questioned if his conclusion is justifiable, and if he considers upland soils which are provided with good natural drainage as normal soils, then we do not see how his statement can longer be sustained. Out of justice to the above writer it should be stated that he makes an exception of sugar beets and adds that ammonia salts are not suited to them.

[1] Die Stickstoffdüngung der landw. Kulturpflanzen, Berlin, 1892, p. 199.

[2] Jahresb. f. Agrikulturchemie, 1886, p. 245. "Die angebliche nachteilige Wirkung der Ammoniaksalze ist vorläufig unbewiesen und tritt keinfalls unter normalen Bodenverhältnissen hervor."

SOME REASONS FOR THE PECULIAR AND OCCASIONALLY CONFLICTING RESULTS OF TRIALS OF NITROGEN IN FORM OF SULPHATE OF AMMONIA AND NITRATE OF SODA.

1. Nitrate of soda leaches more readily than sulphate of ammonia, thus making a wet season more favorable for the latter.

2. The transformation and nitrification of sulphate of ammonia would be favored by considerable moisture.

3. The sulphate of ammonia may furnish sulphur to the plant, and this is essential to its growth; it may also by chemical changes which it sets in operation render available other elements within the soil.

4. The nitrogen in form of nitrate of soda is movable in the soil and in a form ready to act at once, even if the conditions for nitrification are unfavorable.

5. The nitrate of soda may produce chemical changes in the soil different from those produced by sulphate of ammonia, by which other plant food is made available; the soda may partially replace potash and perform its functions in a measure,[1] as claimed by Wagner and Dorsch,[2] who also state that it may under certain circumstances increase the yield by one-half, even when an abundance of potash is applied in connection with it. The soda may also (according to the same writers) increase the water capacity of the soil.

6. It is claimed[3] that like amounts of nitrate of soda will not always give like yields, even though all of the nitrogen is taken up by the plants; in the one case there may be a small crop, containing a high per cent. of nitrogen, and in another, a large crop, containing a low per cent. of nitrogen.

7. Sulphate of ammonia may contain sufficient sulpho-cyanide of ammonia[4] or other impurities, to make it poisonous to vegeta-

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[1] Atterberg, Deut. landw. Presse, 1881, p. 1035, E. S. R., Vol. III, p. 554.
[2] Die Stickstoffdüngung, Berlin, 1892, pp. 227-242.
[3] P. Wagner and Dorsch, Ibid, p. 114.
[4] P. Wagner, Jour. f. Landw, 1873, p. 433.

tion, though as now manufactured this is not likely to be the case.

8. It is possible that the ammonia may enter into combination in the soil, setting sulphuric acid free, which if sufficient bases are not present to bind it, may be injurious to vegetation,[1] or the sulphate of ammonia if not transformed and nitrified may, perhaps, exert a positively injurious action.

9. It appears probable that there is a loss of nitrogen attending the nitrification of the sulphate of ammonia.[2]

OUR OWN OBSERVATIONS ON THE ILL-EFFECT OF SULPHATE OF AMMONIA AS A MANURE.

The attention of one of us was first called to the ill-effect of an application of sulphate of ammonia in 1890 on the Experiment Station farm, in connection with field experiments with fertilizers on Indian corn (maize).[3] The field had been in grass for many years and had become partially overgrown with moss, producing hardly enough grass to pay for cutting. The soil to a depth of from four and one-half to five inches consisted of a sandy loam underlaid by a subsoil of yellow loam, with alternating layers of coarse sand and gravel which furnished good natural drainage. The twentieth-acre plots of which we shall speak in this connection were all manured with muriate of potash and dissolved bone-black at the rate of 150 pounds of the former and 350 pounds of the latter, per acre. Where nitrogen in form of nitrate of soda was added to the above dressing, the results were good; in the case of the plots where nitrogen in form of dried blood was employed it remained a question whether nitrogen had proved of any advantage to the crop or not. Where sulphate of ammonia was applied in increasing quantities the yield was affected as follows:

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[1] Fr. Farsky has shown a direct application of sulphuric acid to the soil to be injurious to vegetation, (Biedmann's Central-Blatt, 1886, p. 458), and Mulder (Chemie der Ackerkrume, Vol. II, p. 37), found humic acid capable of holding the iron of proto-sulphate of iron and of setting the sulphuric acid free.

[2] P. Wagner and Dorsch, Die Stickstoffdüngung, pp. 210–212.

[3] 3rd An. Rpt. R. I. Agr'l Ex. Sta., 1890, pp. 49–56.

	Yield per Acre.		
	Bush. Hard Corn (shelled).	Bush. Soft Corn (shelled).	Lbs. Stover.
Sulphate of ammonia, 112 lbs. per acre	50.71	1 79	3,000
" " " 224 " " "	26.42	2.86	1,500
" " " 336 " " "	15.71	2 86	1,300

When the corn had reached a height of about fifteen inches the better color of that on the nitrate of soda plots began to be noticeable and the same continued until the end of the season. The corn of the sulphate of ammonia plots instead of improving, began to take on a sickly yellow appearance which gradually grew worse until just before the close of the season, when apparently a slight improvement in an occasional hill was visible. The greater the application of the sulphate of ammonia, the worse the corn appeared, which observation is in full accord with the above-mentioned yields. It is of interest to note that on ten other experimental fields in other parts of the State no positively injurious effect of the sulphate of ammonia was noticeable, though it was apparent in two or three instances that it was less effective than the nitrate of soda, though on at least two other fields the sulphate of ammonia plots appeared to stand ahead of those where the blood and nitrate of soda were used, notwithstanding the fact that slightly less nitrogen was applied in this form than on the blood and nitrate of soda plots. At that time two possible causes of the injurious action of the sulphate of ammonia were considered. 1. The possible presence of sulpho-cyanide of ammonia, which might have had a poisonous action. 2. A poisonous action of the sulphuric acid of the sulphate or of the sulphate of ammonia itself, caused by the delayed nitrification, which was, perhaps, attributable to the absence of the nitric ferment or to the possible acidity of the soil and a lack of lime or other bases.

In accordance with a statement made in connection with a review of the above-mentioned results,[1] an experiment was

[1] 3d An. Rpt. R. I. Agr'l Ex. Sta., 1890, pp. 49–56.

planned in the winter of 1890 and 1891 to see if the cause of this ill-effect could not be definitely determined and to find out if the conditions which led to it could not be corrected. The sulphate of ammonia employed in the eleven experiments was from the same lot, and from the fact that no ill-effects were noticeable in ten instances, it did not seem reasonable to conclude that the injurious action upon the plants in our own experiment could have been due to any poisonous impurities. *A sample of the sulphate of ammonia was, however, saved, and subsequent tests proved the absence of sulpho-cyanide of ammonia.*

Alexander Müller,[1] in consequence of experimental observations was led to support the idea first proposed by Pasteur,[2] viz., that the change of ammonia to nitric acid is due directly to the action of living organisms, and this was positively established later by Schützenberger, Schlössing and Müntz.[3] The question was further studied by Warrington[4] and many others, and recently P. Frankland[5] and Winogradsky[6] have succeeded in isolating and cultivating the nitrifying organism. In the course of the many investigations on nitrification it has been ascertained that the process is favored by the following conditions, viz., exclusion of light, the avoidance of too great alkalinity or acidity, the presence of oxygen and proper temperature and moisture. "Below 40° F. and above 131° F. this transformation practically ceases, and its maximum is reached at the temperature of 98° to 99° F."

In view of the foregoing, it remained therefore to consider the possible acidity of the soil and to put it in a condition favorable to nitrification. The soil was tested with litmus paper and found to be decidedly acid, and an application of lime in the caustic state or as carbonate naturally suggested itself. The use of carbonate of lime in artificial nitre beds for increasing the produc-

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[1] Vers. Sta. 16, 1873, p. 273.
[2] Warrington in E. S. R., Vol. III, p. 897.
[3] Compt. rend. 84 p. 301 and 85 p. 1018.
[4] Die Landw. Vers. Sta. 24 p. 161. Jour. Chem. Soc. (Eng.), 1885, Vol XLVII, pp. 758-761.
[5] Phil. Trans. Roy. Soc. 1890, B. 107, cited from E. S. R.
[6] Ann. de l'Institut Pasteur, 1890, p. 218, cited from E. S. R.

tion of nitric acid has long been known.[1] Schultz-Lupitz also mentions the value of carbonate of lime in increasing the efficiency of barn-yard manure[2] on the light soils of his section, and Mærcker claims to have established its value in actual practice in aiding the nitrification of sulphate of ammonia, though P. Wagner and Dorsch have shown[3] that this conclusion was not warranted by the results, and support the statement by the following examples. Suppose one obtains

1.	Without manure	a yield of		100
2.	With sulphate of ammonia	"	"	120
3.	" lime	"	"	110
4.	" lime and sulphate of ammonia	"	"	150

Mærcker's line of reasoning was the following: Comparing 1 and 2, the ammonia gave a gain of 20 on the unlimed soil, while by a comparison of 3 and 4 the increase from the ammonia on the limed soil was 40, and consequently it increases the efficiency of the ammonia salt by aiding its nitrification. Wagner and Dorsch view the question from the following standpoint: The one-sided manuring with lime raised the yield 10, the ammonia alone raised it in like manner 20, but a combination of the two raised the yield 50 in comparison with the unmanured plot. They claim that the only justifiable conclusion is, that the ammonia could not exert its full effect, due to a lack of lime, nor could the lime exert its full effect, due to a lack of ammonia, but when the lack of both was overcome, each was in condition to exert its full effect, and they consequently conclude that the value of lime in increasing the yield with nitrogen in the form of sulphate of ammonia, *especially*, was not proved, for the same results might have been obtained had Mærcker employed nitrogen in the form of nitrate of soda. Had Mærcker, however, employed both nitrate of soda and sulphate of ammonia with and without lime, and found that

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[1] Agriculture, Storer, Vol. I, p. 301.
[2] Mærcker, Beidermann's Central-Blatt, 1889, p. 724.
[3] Die Stickstoffdüngung der landw. Kulturpflanzen, 1892, pp. 199-206.

the lime was of far greater assistance in connection with the former than with the latter, he would then have had reason for concluding that the lime had been of service in aiding the nitrification of the ammonia salt. As analogous to the above case, Wagner and Dorsch mention one of their own experiments in which the following results were obtained:

No manure	gave	a yield	of	32.0 g.
Phosphoric acid	"	"	"	47.6 "
Nitrogen	"	"	"	50.8 "
Phosphoric acid and nitrogen	"	"	"	145.1 "

It is evident in this case that both phosphoric acid and nitrogen were lacking and that neither constituent could exert its full effect until the other was supplied. In our own experiments in another connection we have a number of results which would illustrate the above point as well, if not better, than this example from Wagner and Dorsch.

It appears, therefore, so far as we are aware, at the time our experiment was inaugurated, that no one had shown by any results which could be considered conclusive,[1] that an application of lime on ordinary cultivated soils actually increases the effectiveness of nitrogen in the special form of sulphate of ammonia, in contra-distinction to that in form of nitrate of soda and up to the present we know of no experiment on record which goes to show, in case of a *positive ill-effect*[2] of sulphate of ammonia, that any treatment of the soil of whatever nature is an effective remedy for the same[3] and causes the sulphate of ammonia to become a valuable plant food.

That the less, as well as the occasional ill-effect, of an application of nitrogen in form of sulphate of ammonia was often due to slow or delayed nitrification and that an application of lime or

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[1] Compare Wagner and Dorsch, Die Stickstoffdüngung, Berlin, 1892, p. 217.

[2] Paul Wagner in later experiments noted no ill-effect from the use of large quantities of sulphate of ammonia, (Gas. 35, 601-3), Abs. in Chem. Central-B., 1892, p. 85.

[3] It appears, however, that independent of our own experiments and probably at about the same time Wagner and Dorsch conducted experiments with *summer rape* (Die Stickstoffdüngung, pp. 16-219) for the purpose of ascertaining if an application of carbonate of lime in form of marl was

some other base would overcome it, seemed unquestionable from the experiments on nitrification in general which had already been conducted.[1] Nevertheless a positive proof of its applicability in the field, in a practical and economical way, appeared desirable. This seemed especially the case, owing to the probability that conditions which would be unfavorable to the nitrification of sulphate of ammonia would also tend to retard the nitrification of organic nitrogen, and since organic matter is the chief source of nitrogen in the greater part of the commercial fertilizers on our markets, the economic aspect of the question assumes even greater importance.

Before commencing any extended experiments, it was deemed best to ascertain if the ill-effect of the sulphate of ammonia on the three plots already mentioned (page 212) could be overcome, provided it should repeat itself the succeeding year. Accordingly the following plan was adopted for 1891: a section of the three sulphate of ammonia plots was to be limed and one-half of the

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capable of increasing the efficiency of the nitrogen of sulphate of ammonia by aiding its nitrification. Muck or peat and loam served as soils. On the muck soil the effect of the nitrogen of the sulphate of ammonia without marl was 28 per cent. of that of the nitrogen of soda, but when marl was employed its effect rose to 90 per cent. On the loam soil the corresponding result without marl was 89 per cent. and with marl 90 per cent. On the loam the marl did not increase the efficiency of the nitrogen of the nitrate of soda and the results with both forms of nitrogen show, that the soil was already in a condition favorable to nitrification. On the muck soil the nitrogen of the nitrate of soda gave an inreased yield, as compared with experiments without nitrogen, of 78 grammes without marl and 79.9 grammes with marl, while the corresponding results with nitrogen in form of ammonia show the following increase: 22 grammes without marl and 71 grammes with marl. These experiments therefore show the beneficial effect of carbonate of lime, in form of marl, in increasing the effectiveness of the nitrogen of sulphate of ammonia on muck, probably on account of its facilitating nitrification. Wagner and Dorsch therefore conclude that when lime is lacking in the soil the ammonia salt works badly, and that many of the failures from manuring with ammonium sulphate are attributable to this cause and that we can avoid this by an application to the soil of burned lime or marl. *The results by Wagner and Dorsch were not published until more than a year after we began our work, and did not come into our hands or to our knowledge until all of our experiments herein enumerated were fully planned and a portion of them fully completed.*

Our conditions differed widely from those under which Wagner and Dorsch worked, from the fact that we did not deal with muck soil (which is an exceptional soil, as generally considered), and that in our case the sulphate of ammonia acted like a poison, practically neutralizing the otherwise good effect of the potash and phosphoric acid applied with it. We have, furthermore, experimented with a large number of our agricultural plants, instead of with one plant only (summer rape.)

[1] The value of lime or some base in promoting nitrification is noted by Collard de Martigny, (Jour. de Chim. méd. Tome III, p. 525). Dumas, Compt. rend. T. XXIII, p. 1020. Warrington, Jour. Chem. Soc., December, 1884, Vol. XLV, p. 660, and many others.

section was to receive a dressing of garden soil, which was supposed to contain the nitric ferment.[1]

The idea of trying to inoculate the soil[2] seemed desirable, in view of the possibility of the presence of proto-sulphate of iron which might have destroyed the nitric ferment within the soil.

RESULT OF THE EXPERIMENT IN 1891.

The same kinds of manure were applied as in 1890.[3] They were sown broadcast and harrowed in. After the corn (maize) had made considerable growth, the ill-effect of the sulphate of ammonia became visible and increased in intensity with the advance of the season. Accordingly a section of the three plots was laid out as planned and after considerable unavoidable delay the applications of air-slacked lime and soil were made. These applications which took place on July 27th were made as follows: air-slacked lime at the rate of about five tons per acre was applied as uniformly as possible between the rows, upon a section of the three plots (10, 11 and 12) for a distance of fifty-two feet from the north end of the field. The northern half of this section was now dressed with garden soil and the whole was cultivated in at once. As a result of occasional observations, it did not appear that any improvement in the crop on either section had resulted, until about the close of the growing season when an occasional hill seemed to show signs of recuperation. The improvement was so slight, however, that the results for the year were totally inconclusive. That such was the case did not at that time seem surprising in consideration of the extended drought and the impossi-

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[1] A. Müller, (Die Spüljauchenrieselung bei Paris, Vers. Stationen 23, 1879, pp. 42-44), suggests that sour humus hinders nitrification and that perhaps the value of barnyard manure is in a measure due to its aiding fermentation. He also calls attention to the difficulty sometimes experienced in awakening the activity of artificial nitre beds, and mentions the introduction in such cases of the soil from old beds where the nitric ferment is abundant. The frequently observed poisonous effect of salts of protoxide of iron in the soil is mentioned as possibly due to their antiseptic power.

[2] Salfeld, (Beidermann's Central-Blatt, 1890, No. 18, pp. 239-244) had already shown that the organisms by means of which certain plants are able to avail themselves of free atmospheric nitrogen, may in certain instances be introduced into soils in a similar manner, with decided advantage.

[3] See pages 212, 213.

bility, at so late a date, of mixing the lime with the soil in a proper manner, without doing serious injury to the roots of the growing corn. In view of these considerations it was deemed best to continue the experiment another year.

RESULTS FOR 1892.

During the autumn of 1891 the soil of the unlimed sections of the sulphate of ammonia plots was tested for proto-sulphate of iron with a negative result, which fact, together with the probable universal presence of the nitric ferment, as shown by Müntz,[1] caused us to omit the further application of the garden soil.

In order to insure the presence of sufficient lime to overcome the acidity of the soil, another application of 3.3 tons of air-slacked lime, per acre, was made on the section which had received the dressing the preceding year. This was applied after plowing and was subsequently harrowed in, in a most thorough manner. The kinds and amounts of fertilizers applied, per acre, were as follows: 200 lbs. muriate of potash, 600 lbs. of dissolved boneblack, and sulphate of ammonia at the rate of 120, 240 and 360 lbs.

Indian corn was again selected as the crop for this field, for the reason that the ill-effect of the sulphate of ammonia had been observed with this crop in previous years, and it might be a question if some other crop would be similarly affected.[2] As soon as the corn had reached a height of a few inches a marked difference between the limed and unlimed sections was noticeable. Where the lime had been applied the corn was characterized by its dark green color and vigorous growth, which commenced without delay. In fact the corn upon this section appeared fully equal if not superior to that upon other plots which had received the same amounts of potash and phosphoric acid in connection with nitrogen in form of nitrate of soda. Upon the unlimed section on the other hand, the sickly, yellow color, with the accompanying

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[1] Compt. rend. 110 (1890), p. 1370. Abs. E. S. R., Vol. III, pp. 114–116.
[2] Compare results with lupines, referred to later.

striped appearance of the leaf, which had been noted the two previous years became even more manifest with the advance of the season. As in the preceding years, the greater the application of sulphate of ammonia the worse was the effect.

The following table shows the yield per section of hard corn, soft corn and stover with and without lime.

YIELDS PER ONE-EIGHTIETH ACRE IN 1892.

Fertilizers Used Per Acre.	Limed Section.			Unlimed Section.		
	Hard corn on the cob.	Soft corn on the cob.	Stover.	Hard corn on the cob.	Soft corn on the cob.	Stover.
lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
600 Dissolved Boneblack. 200 Muriate of Potash.. 120 Sulphate of Ammonia	40.25	4.25	50.50	26.75	6.00	30.50
600 Dissolved Boneblack. 200 Muriate of Potash.... 240 Sulphate of Ammonia	40.00	4.00	48.50	6.25	4 00	11.50
600 Dissolved Boneblack. 200 Muriate of Potash.... 360 Sulphate of Ammonia	33.50	5.50	56.00	4.00	4 50	15.00

It is seen that the results on the unlimed section were in full accord with those of the two previous years, viz., the yield decreased with each additional amount of sulphate of ammonia applied, and, as heretofore, in case of a considerable application of sulphate of ammonia, it neutralized, largely or entirely, the otherwise good effect of the potash and phosphoric acid applied in connection with it. In connection with lime, the yield on the section receiving 120 pounds of sulphate of ammonia per acre was decidedly increased; that receiving 240 pounds per acre was about as great, while that receiving the full ration gave somewhat less hard corn, but more stover; which fact may be attributed to the greater amount of available nitrogen on this section and the consequent greater stalk and lesser ear development, or, perhaps in a measure to inequalities of the soil.

The results certainly show in a very marked degree that the lime was a most effective agent in overcoming the ill-effect of the sulphate of ammonia; and that this was due to its facilitating nitrification, by overcoming the acidity of the soil, seemed probable.

EXPERIMENTS IN 1893.

The experiments undertaken this season, were the following: (A) A repetition of the experiment heretofore mentioned, without further addition of lime. (B) Experiment on the coöperative acre on the farm of H. E. Lewis, Hope Valley, R. I., showing the effect of lime in connection with nitrogen in form of both sulphate of ammonia and nitrate of soda. (C) An experiment upon a new portion of land in which nitrogen was used in form of nitrate of soda and sulphate of ammonia, both with and without lime, and in which a large number of our agricultural plants were employed, instead of one (Indian corn or maize) as heretofore. (D) Experiments conducted in pots for the purpose of securing more uniform soil conditions and consequently better comparative results. (E) Plot experiment with Swedish turnips, using nitrate of soda and sulphate of ammonia, with and without lime.

EXPERIMENT "A."

The same plots were used for this experiment as for those of 1891 and 1892, the fresh application of lime being omitted, from the fact that heavy dressings had been applied during the two preceding years, and too great alkalinity might endanger a loss of nitrogen in form of ammonia[1] and also retard nitrification,[2] in, perhaps, as great a degree as decided acidity, both of which conditions must be avoided. Fertilizers were applied at about the same rate as in 1892, viz., 600 pounds of dissolved boneblack, 200 pounds of muriate of potash, and sulphate of ammonia at the rates of 120, 240 and 360 pounds per acre. When the sulphate of ammonia was

[1] Agriculture, Storer, Vol. I, p. 301.

[2] Warrington, Jour. Chem. Soc., Vol. XLVII, p. 758.

used without lime the crop looked fully as bad, if not worse, than that of the previous years, but where the lime was used in connection with it, the corn remained in a most flourishing condition from the outstart, and gave every evidence of producing a decidedly better crop than upon the nitrate of soda or dried blood plots, located near them.

The following table shows the yield per section in 1893, of hard corn, soft corn and stover, with and without lime, the lime having been applied in 1891 and 1892. *(For illustrations see Figs. 1, 2 and 3).*

YIELDS PER ONE-EIGHTIETH ACRE.

Fertilizers Used Per Acre.	Limed Section.			Unlimed Section.		
	Hard corn on the cob.	Soft corn on the cob.	Stover.	Hard corn on the cob.	Soft corn on the cob.	Stover.
lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
600 Dissolved Boneblack. 200 Muriate of Potash.... 120 Sulphate of Ammonia	17.50	3.00	48 50	5.8	3.85	24.28
600 Dissolved Boneblack. 200 Muriate of Potash.. . 240 Sulphate of Ammonia	22 00	4.50	43.50	2.21	1.26	12.31
600 Dissolved Boneblack. 200 Muriate of Potash.... 360 Sulphate of Ammonia	19 00	3 00	50.75	1 64	1 79	7 8

From the above table it will be seen that the lime was fully efficacious in overcoming the ill-effect of the sulphate of ammonia and rendering its nitrogen available to the crop, which conclusion serves to strengthen that already drawn from the results secured in 1892.

EXPERIMENT "B."

The sections of plots used in this experiment formed a part of an acre of land on the farm of Mr. H. E. Lewis, Hope Valley, R. I., which had been used by the Station for coöperative experiments with Indian corn,[1] during 1890, 1891 and 1892. The plots to be

[1] See 3d, 4th and 5th Annual Reports, R. I. Agricultural Experiment Station, pp. 62, 63 and 182, respectively.

considered received an annual dressing of muriate of potash and dissolved boneblack in connection with definite amounts of nitrogen in form of nitrate of soda and sulphate of ammonia. The comparative results with nitrogen in these forms showed, in 1890, that that of the ammonia salt had proved decidedly effective, and, perhaps, superior to that in the form of nitrate of soda, though close conclusions could not be drawn, owing to possible inequalities in the plots. In 1891 and 1892, nitrogen in the form of nitrate of soda gave by far the better results, and even dried blood proved much better than sulphate of ammonia, a condition which was more marked in the latter than in the former season. It should be noted that the nitrogen of the sulphate of ammonia was effective to some degree in both 1891 and 1892 as was shown by a comparison of the yields with those of neighboring plots which had received no nitrogen but had been treated the same in all other respects. The following table shows the yield on the sulphate of ammonia and nitrate of soda sections, both with and without lime. The amounts of nitrogen used in the two forms were, though not exactly identical, practically the same, and for the purpose of this experiment, which is to draw conclusions as to the effect of lime in increasing the efficiency of nitrogen in the form of sulphate of ammonia as compared with that in form of nitrate of soda, the slight difference does not come into consideration.

Table showing the yield of hard corn, soft corn and stover, calculated to one-twentieth of an acre. Season of 1893. (*For illustrations see Figs. 4, 5, 6 and 7*).

Fertilizers Used Per Acre.	Limed Section. Hard corn on the cob.	Limed Section. Soft corn on the cob.	Limed Section. Stover.	Unlimed Section. Hard corn on the cob.	Unlimed Section. Soft corn on the cob.	Unlimed Section. Stover.
lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
600 Dissolved Boneblack .. 200 Muriate of Potash.. 120 Sulphate of Ammonia..	111.0	13.8	107 2	49.9	21 0	86 3
600 Dissolved Boneblack . 200 Muriate of Potash...... 240 Sulphate of Ammonia..	101.8	13.8	88 8	18.3	14.0	66.1
600 Dissolved Boneblack... 200 Muriate of Potash...... 360 Sulphate of Ammonia..	110.3	16.3	120.9	34.0	9 7	51.0
600 Dissolved Boneblack... 200 Muriate of Potash...... 160 Nitrate of Soda.........	108.7	12.3	87.6	79 2	14 1	83.6
600 Dissolved Boneblack... 200 Muriate of Potash...... 320 Nitrate of Soda	105.7	16.1	122.5	116.9	11 8	104 5
600 Dissolved Boneblack... 200 Muriate of Potash...... 480 Nitrate of Soda.........	125 3	10 4	99.6	114.8	12 5	106.4

From an inspection of the above table it will be noticed that where nitrogen in form of nitrate of soda was employed, the lime raised the yield of hard corn in but two cases, and where the largest amount of the nitrate was applied it raised it but slightly. In the case of nitrogen as sulphate of ammonia, however, the lime was remarkably beneficial. It seems probable that the least effect of the nitrogen in the form of sulphate of ammonia was due chiefly in this case to its tendency to increase the acid condition of the soil, the result of which was delayed nitrification, for which the lime proved an efficient remedy. Tests of the soil established its decided acidity, which fact further strengthens the above conclusion.

EXPERIMENT "C."

This experiment was conducted on four of the permanent experimental plots (Nos. 23, 25, 27 and 29), the previous preparation

FIG. 1. Kingston Experiment, 1893.

The foreground of the three rows in the center shows the effect of 240 lbs. of sulphate of ammonia per acre when used *without* lime.

FIG. 2. Kingston Experiment, 1893.
Showing the effect of 240 lbs. of sulphate of ammonia per acre when used *with* lime.

FIG. 3. Kingston Experiment, 1893.

Showing the effect of 360 lbs. of sulphate of ammonia per acre when used *with* lime. The effect of the same *without* lime was much worse than that shown by Fig. 1, but owing to the breaking of the negative it could not be reproduced.

FIG. 4. Lime. FIG. 5. No lime.

Nitrate of Soda.

FIG. 6. Lime. FIG. 7. No lime.

and plan of which have been described in full elsewhere.[1] These plots are separated from each other by unmanured spaces of three feet, and, furthermore, they are so arranged that a border of three feet on each side and of six feet across each end is fertilized at the same rate as the real plot which lies within. It is a frequently observed fact, to which especial attention has been called by Marek,[2] that the outside rows on such plots are frequently better than the others, and this plan provides that this border may be harvested separately if desired, and only the results upon the inner plots be employed in comparative work. The inner plots are 181½ feet long and 24 feet wide, making an area of one-tenth of an acre. In 1891 a crop of beans and in 1892 a crop of Indian corn had been grown, without manuring, upon all of these permanent plots, for the purpose of ascertaining if they were sufficiently uniform for comparative work. Such was found to be the case in respect to the four above mentioned plots, which fact, together with their location, parallel and adjacent to one another, determined their selection for this experiment. The four plots were manured alike, with muriate of potash at the rate of 200 pounds per acre, and dissolved boneblack at the rate of 600 pounds per acre. The two plots toward the west (Nos. 23 and 25) were given an additional dressing of 360 pounds per acre of sulphate of ammonia, and the two toward the east a dressing of nitrate of soda at the rate of 465 pounds per acre, or at such a rate that the amount of nitrogen applied upon each plot was exactly the same. One of the sulphate of ammonia plots (No. 25) and one of the nitrate of soda plots (No. 29) received in addition a dressing of air-slacked lime at the rate of 5,400 pounds per acre. The lime was thoroughly harrowed in and was applied independently of the other manures. Rows three feet apart were laid out across these four plots in which seeds of a large number and variety of crops were planted. The object of this experiment was a two-fold one, viz., to further

[1] 4th Annual Report, R. I. Agricultural Experiment Station, 1891, pp. 13-15.

[2] Düngungswerth der Phosphate von G. Marek, Dresden, 1889.

test the value of air-slacked lime in aiding the nitrification of sulphate of ammonia and to note the growth of our agricultural plants on acid and practically neutral soils. For the purposes in view it seemed necessary to employ, as was done, both nitric and ammoniacal forms of nitrogen with and without lime. Details in the line of soil acidity and its effect upon plant growth, which are but briefly referred to here, will be treated more fully in a later publication. We shall confine ourselves in this connection more especially to a consideration of the results in their bearing upon the use of lime in overcoming the ill-effect of sulphate of ammonia and upon the question of nitrification. So far as time allowed, and in the case of those crops where it seemed especially desirable, the amount of dry matter was determined with a view of furnishing a more accurate basis for comparisons. Since the space at disposal only allowed one or two rows for each crop, the yields do not admit of such close comparisons as otherwise, owing to slight variations in fertility, due either to the soil or to the application of the fertilizers, or both, and which are always to be met with even on the most uniform field. Since, in the equipment of this station, no provision was made for systematic pot experiments the method of experiment adopted by us secured the best which was possible, and we believe the results in general are sufficiently striking to convey conviction to all who take the trouble to give them their careful attention. In the following pages will be found a detailed discussion of the results with the individual crops.

COMMON RED CLOVER (*Trifolium pratense*).

Owing to the fact that this clover does not attain its full development until the second year, no attempt was made to harvest and weigh the crop. From frequent observations it was plainly manifest that on the sulphate of ammonia plots which had not been limed, the clover was not in a normal condition, as indicated by its yellow appearance and limited growth. That on the other three plots was of good color and exhibited a flourishing growth,

even to the close of the season. There was little visible difference between the nitrate of soda and sulphate of ammonia plots which were limed and the nitrate of soda plot without lime.[1] It was evident that the sulphate of ammonia if not used in connection with lime was probably of no benefit and perhaps positively injurious to the clover.

CRIMSON CLOVER (*Trifolium incarnatum*).

From observations throughout the season it was evident that crimson clover and the common red clover were similarly affected. The yellow and sickly appearance of the clover on the sulphate of ammonia plot, which had received no lime, continued manifest, while the clover upon the other three plots was in fine condition. The following gives the yields, as harvested, and also the amount of absolutely dry matter.

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Crimson clover, green	3.75	20.75	19.5	26.5
" " absolutely dry	1.23	5.36	4.78	6.43

By comparing the yields of dry matter on plots 27 and 29 where nitrogen was used in the form of nitrate of soda, it will be seen that the greater yield on the limed plot amounted to 1.65 pounds, while in the case of the sulphate of ammonia plots, 23 and 25, the gain on the limed plot amounted to 4.13 pounds. It seems probable that the greater result in the latter case was due to the action of the lime in overcoming the acidity of the soil by which it also favored the change of the ammonia into nitric acid, in which form the nitrogen not only became a valuable source of plant food, but the sulphate of ammonia lost the injurious properties which it possessed when used without lime.

[1] Experiments with clover and lime in connection with other manures, on an extended scale, have shown, on our soil, that lime will insure a good "catch" of clover and a more vigorous growth, than can be produced by any of the various combinations of fertilizers, without lime.

COMMON WHITE BEANS.

It was interesting to note that the beans were more nearly uniform in appearance on the four plots than the clovers, and it was true of the leguminous crops generally, that they succeeded much better on the sulphate of ammonia plot without lime, than the other families of plants under experiment. Owing to a misunderstanding, the beans were not separated from the straw and each weighed separately, as intended, but the total weights were taken when pulled, and the moisture of the entire plant determined at once. The following table shows the results thus obtained:

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Common white beans, as pulled including straw	4.12	5.94	4.81	5.25
Common white beans, including straw, absolutely dry	1.85	3.24	2.82	2.65

By a comparison of the dry matter of plots 27 and 29 it will be seen that the yield on the plot receiving lime was slightly less than on plot 27 where no lime was applied; the difference, however, is so slight that it is wholly within the probable limit of error due to slight variations in the plots. By comparing plots 23 and 25 it will be seen that a very marked difference in the amount of dry matter exists in favor of the limed plot. The beans upon plot 23 were more backward and consequently not so ripe as those upon plot 25, which accounts for the lesser amount of dry matter which they contained. At no time during the season was the crop on plot 23 equal in appearance to that on plot 25, though the final results would doubtless have been more favorable to the former had the season been long enough for the crop to have fully completed its growth. The lime in this case appeared to be decidedly efficacious when used in connection with the sulphate of ammonia, though not in so great a degree as in the case of some other crops.

WHITE PODDED ADZUKI.

This is a Japanese bean, introduced into this country by Prof. W. P. Brooks of the Hatch Experiment Station, of Amherst, Mass., through whom the seed was obtained. This plant was even more characteristic than many others of the leguminous family in its ability to grow quite well, even upon the unlimed sulphate of ammonia plot. No attempt was made in this case to let the crop reach full maturity. It was harvested at the same time on all the plots and while the beans were still soft. The yields are shown by the following:

No. of plot	23	25	27	29
	Sul. Ammonia alone.	Sul. Ammonia + lime.	Nitrate Soda alone.	Nitrate Soda + lime.
	lbs.	lbs.	lbs.	lbs.
White Podded Adzuki, green......	13.62	22.87	22.81	18.00
" " " absolutely dry....	3.20	5.02	5.24	4.31

Comparing in this instance plots 27 and 29, it is evident that the lime had proved of no benefit in connection with nitrate of soda, and the question might well be raised if it had not been a source of injury. These results should be compared with those secured with cow peas, soja beans, and more especially with blue lupines, in connection with which this point will be further considered. By a comparison of plots 23 and 25, it will be observed, that the lime was beneficial when used in connection with sulphate of ammonia.

COW PEA (*Dolichos.*)

This plant is grown in the South, quite extensively, and its value has been tested to some extent in the North for forage and for green manuring. It is also a member of the leguminous family. Since this pea does not ripen its seed in our climate the crop could be harvested only in a partially immature condition. The following table shows the yields. (*For illustration see Fig. 8*).

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Cow pea, green	10.37	12.31	12.00	9.44
" " absolutely dry	1.94	2.15	2.13	1.70

By a comparison of plots 27 and 29 we see, as was the case with the White Podded Adzuki, that nitrogen in form of nitrate of soda gave better returns without lime than with it, while in the case of nitrogen in form of sulphate of ammonia the limed plot gave better returns than the unlimed.

SOJA BEANS (*Soja hispida.*)

This plant belongs to the leguminous family and is grown chiefly in the Orient where the beans are used for sauce and for flavoring beef and other dishes. It is also cultivated as an oil plant.[1] This plant, like others of the same family, has been recommended as a nitrogen gatherer and hence as especially valuable for green manuring. The crop was harvested while the beans were still soft, or a short time before the plants reached maturity. The weights secured were as follows. (*For illustration see Fig. 8*).

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Soja beans and straw, green	9.38	7.88	21.81	18.00
" " " " absolutely dry	2.68	2.08	5.98	4.46

Here again as in the case of others of the leguminous plants, the nitrate of soda alone, gave better returns than when used with lime. We see by a comparison of the yield of plots 23 and 25 that in this case, contrary to all the previous observations, nitrogen in the form of sulphate of ammonia gave greater returns when used alone than when used with lime. It is of interest to note that similar results were obtained with the blue lupine which we are about to consider.

[1] Description from Henderson's Handbook of Plants and General Horticulture, p. 417.

BLUE LUPINE (*Lupinus perennis.*)

This is still another member of the leguminous family. Various species of the lupines are in great favor for green manuring in Germany, especially on sandy soils, where they grow luxuriantly without nitrogenous manures. The seeds are sometimes used for feeding and the straw for litter, but in such cases the seed must receive special treatment before it is fed, for the purpose of removing a poisonous, bitter principle, which gives rise to a disease known as "Lupinose."

The crop was harvested before it was fully ripe and the weights represent those of both straw and beans.

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Blue Lupine, as harvested	12.63	4.25	14.44	5.56
" " absolutely dry	2.97	1.21	3.28	1.54

It will be seen that the results with the blue lupine are in full accord with those secured with the soja bean, viz., in the case of nitrogen in both forms, an application of lime reduced the yield. Adolf Mayer[1] found on the sandy heath between Wageningen and Renkum, Holland, that a small application of carbonate of lime in the form of marl was of benefit to potatoes but without beneficial effect upon the crop of lupine which followed. Schultz-Lupitz[2] states that lime, on his sandy heath soil, injured lupines, but that by subsequent applications of potash and phosphoric acid he was enabled to make them succeed again. H. Wilfarth[3] also states that "on lime and wet soils lupines do not succeed well." So far as we have been able to ascertain no explanation of this action of lime on lupines has been offered. It appears, however,

[1] Jour. f. Landw. 1882, p. 141. Biedermann's Central-Blatt, 11, p. 84. Tijdschrift voor Landbouwkunde Jahrg. 1881, 12 Lief. s. 371-379.

[2] Landw. Jahrbücher, Vol. X.

[3] E. S. R., Vol. V, No. 1, p. 113. Deut. landw. Rundschau, 1882, Nos. 8, 9, 10 and 11. Abs. in Chem. Central-Blatt, 1893, No. 22, p. 990.

probable from our observations that the lupine succeeds best on acid soils, and that possibly the ill-effect of the lime may be attributed to its overcoming this acidity. It is possible that the whole question hinges upon the action of the lime in its bearing on the development, upon the root, of the organism through which the plant obtains its supply of atmospheric nitrogen. The results secured by Hellriegel and others go to show that it is probably not one and the same organism which performs this function for each of the "nitrogen gatherers," and it is possible that the conditions for their development are not identical. It is certainly remarkable that an application of carbonate of lime injures the lupine, and, perhaps, certain other of the leguminous plants, and is of positive benefit to clover. A satisfactory solution of this interesting problem would be most desirable.

"GRANGER" PEA (*Pisum sativum*).

The peas came up scattering and made an unsatisfactory growth, yet it was very evident that the plants upon the unlimed sulphate of ammonia plot were decidedly behind the others. The vines with the pods still on them were pulled and weighed while yet green. The following are the weights thus secured:

No. of plot	23	25	27	29
	Sul. Ammonia alone.	Sul. Ammonia + lime.	Nitrate Soda alone.	Nitrate Soda + lime.
	lbs.	lbs.	lbs.	lbs.
"Granger" Pea, pods and vines	0.44	4.94	1.88	2.88

Comparing plots 23 and 25 it will be seen that where nitrogen was employed in the form of sulphate of ammonia the lime was of decided assistance. The irregularity in the crop renders it impossible to draw any close conclusion in regard to plots 27 and 29, though it would appear that the lime, even here, had also proved beneficial.

VARIETIES OF INDIAN CORN (MAIZE).

Four varieties of corn were employed, viz., white capped and dent corn (varieties of ordinary field corn), also pop corn and

sweet corn. The following weights represent the stover and immature ears at the time of cutting and after the crop had partially dried by standing in the field for twenty-one days:

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
White Capped Corn, green	3.06	13.69	12.63	8.75
" " " after drying.	1.81	7.13	6.50	4.63
Dent Corn, green	2.50	15.00	9.25	9.88
" " after drying	1.56	7.19	4.06	4.75
Pop Corn, green	3.69	27.25	18.63	30.00
" " after drying	2.00	13.38	9.56	14.88
Sweet Corn, green	2.95	24.50	14.13	29.75
" " after drying	1.38	13.81	8.13	16.81

The corn on all the plots suffered more or less injury during the two severe storms which occurred toward the close of the season, yet the results, on the whole, show very strongly, in each case, that the lime when used in connection with the sulphate of ammonia was remarkably effective. Where lime was used in connection with the nitrate of soda, there was a very decided increase in the case of the sweet corn and pop corn, a slight increase in case of the dent corn and a loss in the case of the white capped corn. It is impossible to conclude whether these variations in the results upon the nitrate of soda plots were due to the individual characteristics of the corn, or to unequal damage from storms or other causes. From a careful comparison of the yields, it is strikingly shown that the effect of the lime when used in connection with the sulphate of ammonia was far greater than in connection with nitrate of soda, showing clearly that the gain from the use of lime in the former instance must be attributed to some other effect than that of a direct fertilizer, and probably to its action in overcoming the acidity of the soil whereby it not only put the soil in a condition better adapted to the plant but probably also aided the nitrification of the ammonia.

VARIETIES OF BEETS (*Beta vulgaris*).

Four varieties of beets were employed. The seed germinated upon all four plots, though the young plants on the unlimed sulphate of ammonia plot presented an extremely unhealthy appearance, and in the case of three of the varieties, all of them gradually died without further growth. On the unlimed nitrate of soda plots many of the plants failed to develop, and those that did succeed in getting a fair start remained far behind those on the limed plots throughout the entire season. Wherever lime was used, whether in connection with nitrate of soda or sulphate of ammonia, the plants appeared to remain in a vigorous and healthy condition. The following table shows the weights of tops and roots at the time of harvesting. (*For illustrations see Figs. 9, 10, 11 and 12.*)

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Eclipse Table Beets, roots	Nothing.	18.50	4.50	35.00
" " " tops	0.25	23.50	4.50	34.25
French Sugar Beets, roots	Nothing.	23.50	3.00	36.50
" " " tops	"	37.25	2.25	58.25
Long Red Mangel, roots	"	35.25	5.80	44.00
" " " tops	"	25.75	4.00	31.50
Golden Tankard Beets, roots	"	36.50	4 00	43.00
" " " tops	"	12.00	3.25	25.00

By an examination of the weights on plots 23 and 27 it will be seen that with nitrogen in the form of nitrate of soda a small yield was obtained, but that with one exception the beets positively refused to grow where nitrogen in form of sulphate of ammonia was applied. It is evident, therefore, by a glance at the yields on plot 25 that the lime had overcome the ill-effect of the sulphate of ammonia which was so marked on plot 23. Under ordinary circumstances one would be inclined to attribute the gain on plot 29 over that of plot 27 wholly to the direct manurial action of the lime.

In this case, however, it appears highly probable that the acid condition of the soil was unfavorable to the growth of the young beet plants, and that the gain on plot 29 over that on plot 27 must be attributed, not so much to the direct manurial effect of the lime, as to its action in overcoming the intense acidity of the soil. That the chief value of the lime is to be found in the latter action seems highly probable, and it is a point which we hope to determine by future experiments. It will be seen that the yields on the limed sulphate of ammonia plot are below those on the corresponding nitrate of soda plot, but whether this is due to incomplete nitrification of the sulphate of ammonia or a loss of nitrogen in the process (see page 212), or to the additional fertilizing action of the soda[1] on plot 29, or perhaps a combination of these causes, it seems impossible to conclude from this individual experiment only.

CARROTS (*Daucus carota*).

The carrot seed germinated on all of the plots, but as in the case of the beets it was noticed that most of the young plants on plot 23 gradually died. On plot 27, however, the growth appeared to be a healthy one, though not as vigorous as upon the limed plots on either side. Below are given the yields of roots and tops. (*For illustrations see Figs. 13, 14, 15 and 16*).

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Victoria Carrots, roots	Nothing.	32.50	17.50	31.25
" " tops	"	10.00	7.50	9.25
Mastodon Carrots, roots	0.38	53.00	21.25	37.50
" " tops	0.06	17.50	7.75	12.50

By a comparison of the yields on plot 23 with those on 25 it is evident that the lime overcame the ill-effect of the sulphate of ammonia, and in this respect the results agree with those noted with

[1] On the question of the partial substitution of soda for potash by certain plants, see Wagner and Dorsch, Die Stickstoffdüngung der landw. Kulturpflanzen, Berlin, 1892, p. 227; also A. Atterberg, Deut. landw. Presse, 1891, p. 1035. Abstract in E. S. R., Vol. III, p. 554.

beets. The yield on plot 29 also shows the beneficial action of lime when used in connection with nitrate of soda. In the case of the beets, it was noticed that plot 29 gave a decidedly better showing than plot 25, but in case of the carrots, plot 29 shows a total yield of roots amounting to 68.75 pounds, while the corresponding weight upon plot 25 is 85.5 pounds. It would appear, therefore, that nitrification must have progressed properly on plot 25, and that the results must be attributed either to some special value of the sulphuric acid of the sulphate of ammonia, in connection with the carrots, or to a similar effect of the soda on the beets on plot 29, or perhaps to a combination of both. It will be of interest to determine if sulphate of ammonia is superior for carrots, to nitrate of soda. We hope to secure additional data in this line the coming season.

RUTA BAGAS OR SWEDISH TURNIPS.

From various field observations it was evident that this crop was better able to withstand the conditions prevailing on the unlimed sulphate of ammonia plot than were the beets and carrots. The effect of the lime was so marked on the one row of white rock turnips that five rows of another variety were planted later, for the sake of securing additional data. The following were the yields obtained at harvesting. (*For illustrations see Figs. 17, 18, 19 and 20.*)

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Ruta Bagas, one row, roots	10.00	46.00	58.50	77.00
" " " " tops	3.25	19.25	17.25	38 50
" " five rows, roots	14.75	142.50	90.25	165.00
" " " " tops	13.00	73.00	61.00	82.50

From an inspection of the yields upon plots 23 and 25 it is evident that the lime had wonderfully increased the effectiveness of the nitrogen in form of sulphate of ammonia and in fact in a far greater degree than in connection with nitrate of soda, as may be

seen by comparing plots 27 and 29. Comparing plots 25 and 29 it is evident that the nitrate of soda in connection with lime was superior for ruta bagas to the sulphate of ammonia and lime, in which respect the results accord with those with beets.[1] It appears possible from these results that the soda may be of especial value to both beets and ruta bagas, which point we hope to follow up by further experiments.[2]

VARIETIES OF SORGHUM.

The following varieties of sorghum were employed: Amber Sugar Cane, Kaffir Corn and Jerusalem Corn. From the field observations made during the season, it was evident that the conditions of the soil were such that these crops could not flourish even where nitrogen in the form of nitrate of soda was applied and in connection with these plants lime exerted a strikingly beneficial influence. The following are the yields as shown by weights taken at the time of cutting and again after the crop had been dried under cover for some weeks at ordinary temperature. (*For illustrations see Figs. 21, 22, 23 and 24*).

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Amber Sugar Cane, as cut	0.02	13.19	0.56	7.50
" " " air dry	0.01	7.75	0.29	3.06
Kaffir Corn, as cut	0.05	11.63	2.44	9.19
" " air dry	0.02	7 75	1.29	4.38
Jerusalem Corn, as cut	Nothing.	2.75	0.50	1.75
" " air dry	"	1.34	0.29	0.78

It is evident from a comparison of the yields on plots 23 and 25 that the lime had overcome the ill-effect of the sulphate of am-

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[1] See page 235.

[2] R. Warrington (The Gas Engineer's Annual for 1889; abs. in Beidermann's Central-Blatt, 1889 p. 448), in a summary of results at Rothamstead and Woburn, states that even when used in connection with an abundance of superphosphate and potash, sulphate of ammonia was far inferior to nitrate of soda for Mangold wurzels; the same was true in a *less* degree with certain other crops. This Warrington attributes to the greater indirect action of the nitrate of soda, in setting free mineral constituents within the soil which in turn are beneficial to the plant.

monia. In the decided gain from the use of lime in connection with nitrate of soda these plants show results much like the beets and even more marked than the carrots and ruta bagas. By a comparison of the yields on plots 25 and 29 it is seen that in each case the nitrogen in form of sulphate of ammonia gave better results when applied with lime than did nitrogen in form of nitrate of soda. In this respect the results stand in strong contrast to those secured with the beets and ruta bagas, but whether this is attributable to an especial beneficial effect of the sulphuric acid of the sulphate of ammonia, or to an ill-effect of the soda upon these plants, or perhaps to both causes, remains to be ascertained by future experiments.

SUNFLOWERS (*Helianthus annuus*).

The varieties known as the Mammoth and Black Giant served for the experiment. The crop was cut just before the seeds began to drop, and the weights are those of the two varieties harvested together, and represent both seeds and stalks at the time of cutting:

No. of plot	23	25	27	29
	Sul. Ammonia alone. lbs.	Sul. Ammonia + lime. lbs.	Nitrate Soda alone. lbs.	Nitrate Soda + lime. lbs.
Sunflowers, seeds and stalks	3.25	54.88	40.19	43.8

The plants upon plot 23 grew but little and presented a sickly appearance throughout the entire season, while those upon the other plots were in a flourishing condition. The better appearance of the plants on plot 25 as compared with those on plot 29 was also quite marked. That the lime overcame the otherwise ill-effect of the sulphate of ammonia, there can be no question as seen by a comparison of the yields on plots 23 and 25. As was the case with the sorghum, the sulphate of ammonia with lime was more efficacious than nitrate of soda with lime.

KALE (*Brassica oleracea acephala*).

The field observations on the kale gave sufficient evidence of the fact that the plants on the sulphate of ammonia plot without

lime were not in a thrifty condition, and in fact many of the young plants soon died. The crop upon the four plots was cut at the same time and weighed at once, in its green condition:

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Kale, green	16.06	119.56	92.56	139.56

Comparing the yields on plots 27 and 29 it will be seen that the gain where lime was used in connection with the nitrate of soda amounted to but 40 lbs., while by a comparison of plots 23 and 25 it will be seen that the gain due to the lime amounted to 103.50 lbs. Now if the gain of 40 lbs., in the first instance, be attributed to the joint action of the lime as a manure and as a neutralizer of the acidity of the soil, it is evident that its greater efficiency in connection with the sulphate of ammonia was probably due to its favoring nitrification, and to the fact that the sulphate of ammonia undoubtedly increased the acidity of the soil beyond that of plot 27. We are led to believe that the kale will succeed better on acid soils than the sorghum and beets.

CABBAGES (*Brassica oleracea*).

Both early and late varieties of cabbages were employed, though but few of the late sort reached maturity. The two lots were harvested at different dates; the weights of the total crop and trimmed heads were secured in connection with the early variety, and the total weight, and weight of the heads untrimmed, in connection with the late ones:

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Early Cabbage, total crop	10.50	97.25	90.50	116.50
" " trimmed heads	None.	50.50	52.75	57.00
Late Cabbage,[1] total crop	16.75	120.00	46.00	109.00
" " untrimmed heads	None.	40.00	10.00	68.00

[1] But few of this variety reached maturity.

By a comparison of the gains of plot 29 over plot 27 and of plot 25 over plot 23, it appears probable that the value of the lime in connection with the sulphate of ammonia on plot 25, was due chiefly to its aiding nitrification. The results with the late cabbage are less conclusive on account of the immaturity of the crop. It will be seen that they show a greater weight of total crop on the plot with sulphate of ammonia and lime than on the nitrate of soda and lime plot. In the case of the early cabbages, however, which with the exception of those on plot 23, reached maturity, it will be seen that the results agree with those secured with the kale, viz., they show that the yield with nitrate of soda in connection with lime was greater than that with sulphate of ammonia and lime. It will be an interesting question to note the effect of these forms of nitrogen in the future and to determine in connection with what crops, if any, the nitrate of soda or sulphate of ammonia is of especial benefit.

SPINACH (*Spinacea oleracea*).

Two varieties of spinach were grown, but as the results with both were uniformly the same only one variety was harvested and weighed, the other being left standing throughout the season for the benefit of visitors who came at frequent intervals to look over the experiments. The seed germinated on all four of the plots, but not a single plant on the unlimed sulphate of ammonia plot was able to survive for any length of time. On the plot where nitrate of soda was applied without lime, a careful observer would have noted that the plants were scattering, and would have concluded that the seed had not germinated well. In fact, however, this was not the case, but only a part of the plants lived, few, if any, of which made a satisfactory growth. The limed nitrate of soda plot gave a decidedly better showing than the limed sulphate of ammonia plot. The weights of fresh and absolutely dry material are given below. (*For illustrations see Figs. 25, 26, 27 and 28*).

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Spinach, green	Nothing.	9.38	0.69	18.38
" absolutely dry	Nothing.	2.03	0.12	2.97

The results, as shown in the above table, are, with one exception, practically in accord with those obtained with beets and sorghum, for, as will be seen by reference to the table, the yield on plot 23 was nothing, and that on plot 27, even with nitrogen in a readily available form, was not much better, while the crop on both plots where lime was employed was good. In another respect the results agree with those secured with the beets, for the yield is much greater on plot 29 than on plot 25, but they disagree with those secured with the sorghums, for the latter did better in every case on plot 25 than on plot 29. It might at first thought be argued that the lesser effect of the sulphate of ammonia was due to the fact that the spinach matures early and that possibly nitrification progressed so slowly that the crop did not get enough nitrogen for its needs, while with the nitrate of soda such was not the case. When we consider the results with the beets, however, it is noteworthy that they continued to grow throughout the entire season, and notwithstanding this, show greater yields on the limed nitrate of soda plot than on the limed sulphate of ammonia plot; in consideration of which fact it would appear probable that the soda was of especial advantage to the spinach or that the sulphuric acid was objectionable, or perhaps, both. From these and observations on several other plants it appears probable that the poor results on plot 27 were attributable to the acidity of the soil, and that the beneficial action of the lime was probably more due to its overcoming this acidity than to its direct action as a fertilizer. The small yield on plot 27 renders it practically impossible from the results with this crop only, to conclude that the nitrification of the sulphate of ammonia had been promoted by the use of lime, yet as such a conclusion appears evident from the results with many other plants which are probably less

severely affected by the acid condition of the soil, there seems no reason for any conclusion to the contrary, from these results.

IRISH POTATOES (*Solanum tuberosum*).

The variety of the Irish potato employed in this experiment was that known as the Early Rose. The tubers were cut in one lot, and two rows were planted across the four plots. The weights recorded below represent the total yield of merchantable[1] and small tubers, from the two rows. The potatoes were not harvested until the vines were dead, and consequently no attempt was made to determine the weight of the latter. (*For illustrations see Figs. 29, 30, 31 and 32*).

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Early Rose Potatoes, total crop..	6.25	13.50	13.56	13.94
" " " merchantable tubers	none.	6.16	2.98	7.36

The less effect, or possible ill effect, of the sulphate of ammonia on plot 23 is very marked, when the results are compared with those on plot 27, where nitrate of soda was used, and it is evident from the yield on plot 25 that the lime was efficacious in overcoming this condition. The total yields on plots 25, 27 and 29 show but slight variations, and stand in this respect in strong contrast to the spinach, beets and sorghum, which produced but slight crops upon plot 27. By an examination of the total yields on plots 27 and 29 one would not be justified, owing to the slight difference, in concluding that the lime had been of any direct benefit to the crop, but when we compare the yields of merchantable tubers on plots 27 and 29, we are struck at once by the fact that while the lime had not decidedly increased the total yield, it had for some reason increased the proportion of tubers of merchantable[2] size. In the case of the sulphate of ammonia, it will

[1] Tubers weighing 2 oz. or over were classed as merchantable.

[2] A similar observation has been made by Heiden, Wie wird schwerer, roher Boden (Neuland) fruchtbar gemacht? Hannover, 1893, p. 283.

be noted that without lime no merchantable tubers were obtained, but where lime was used the total yield was not only raised 7.25 pounds, but there was also a yield of merchantable tubers amounting to 6.16 pounds, which weight is in quite marked contrast to that on plot 27 without lime. If it should prove, upon further experiment, that these results are not exceptional but that the lime really hastens the maturity of the crop on our soils, the financial bearing of the question will prove of importance, especially in a state like our own, where the early potato crop is a prominent one. Such being the case, it is our purpose to study this question the coming season and by a larger number of observations determine, if possible, whether or not the results of this year will repeat themselves. One other point must be considered in connection with the use of lime in this experiment, viz., its effect upon the development of the potato "scab." From a careful inspection of the crop it was evident that where the lime was used the potatoes were far more scabby than upon the unlimed plots. If the lime hastens the maturity of the potato, it may be possible that the greater amount of growth and consequent greater cork development about the point which is injured by the growth of the scab fungus, may account to some extent for the greater amount of scab on the limed plots. The lime may also supply carbonic acid to the fungus or affect the chemical composition of the tuber, thereby rendering it more favorable to the development upon it of the scab germs. (For a complete discussion of other points in the same line as well as for a general resumé of the potato scab question, see Bulletin 26, of this Station, pp. 141–156.) It appears from our own and other observations that the lime *in some way* increases the scabbiness of the product, and the question which naturally presents itself is the following: If it should prove on further experiment that liming is of decided value in hastening the maturity of the crop, how shall we derive the benefit from the lime and at the same time avoid the scab? This question has already been discussed in all its bearings in Bulletin 26, and we will merely state here that at the

present time the scab is supposed to be produced directly by the injury caused by the growth upon the tuber of a minute plant or fungus. Now the germs which produce this fungous growth may be in the soil already or may be on the "seed" potatoes themselves, even if they have no appearance of the scab (i. e. they may have become contaminated by being in contact with scabby potatoes or by being placed in bins, barrels or bags where scabby potatoes had previously been stored). If the soil is known to be contaminated from previous scabby crops, the difficulty may be avoided by choosing new land in the future. It seems probable that the germs already on the potatoes to be planted may be very effectually removed by the treatment with corrosive sublimate as described in Bulletin 26, p. 155. If the germs are destroyed before the potatoes are planted and uncontaminated soil is employed, it is highly probable that liming may be resorted to without hesitation. It is our plan to test the matter thoroughly the coming season. The discovery by one of us of the fact of the acidity of our soil and its probable lack of carbonate of lime, led to the application of lime by Director Flagg in connection with the clover crop, and this treatment has been followed by marked success.[1] A good "catch" of clover has been secured by the use of lime, where without it the results have been far from satisfactory. Now the clover is supposed to be capable of drawing a considerable portion of its nitrogen supply from the air within the soil and it also furnishes an excellent crop to precede potatoes, so that regardless of the possible favorable effect of the lime on the maturity of the potato crop, it is of the utmost importance to know how to derive the benefit from the lime on the clover and to avoid its scab-producing tendency on the potato crop which follows.

TOMATOES.

Tomato plants of the same variety and of as nearly uniform size as possible were set out across the four plots. The plants suffered

[1] See this Report, pp. 193 and 194.

considerable injury from the large green tomato worm, and while a considerable portion of the fruit was still immature it was so severely attacked by Colorado potato beetles that it became necessary to harvest the crop or to resort to Paris green, the former course being followed. The following table gives the total weight of fruit, the weight of ripe and green fruit and the weight of the vines.

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Tomatoes, total fruit	3.07	25.81	29.63	41.62
" ripe fruit	1.63	15.31	15.69	10.06
" unripe fruit	1.44	10.50	13.94	31.56
" vines, green	7.81	13.81	16.13	26.50

From the field observations it was evident that the plants on plot 23 were not flourishing. They remained very small and bore but little fruit. It should be stated that the vines on plots 23, 25 and 27 suffered much more from the green worm and Colorado potato beëtle than on plot 29. By a comparison of the yields of fruit on plots 27 and 29 and plots 23 and 25 it is obvious that the lime was remarkably beneficial when used in connection with the sulphate of ammonia, in fact much more so than in connection with nitrate of soda. Notwithstanding the fact that the vines and fruit on plot 27 suffered more from insect depredations than upon plot 29, the field observations, together with the decidedly greater weights on plot 29, nevertheless point to the conclusion that lime was of decided benefit, even in connection with nitrate of soda, though to what degree this may have been due to its direct action as a manure or to its effect in overcoming the acidity of the soil, remains to be determined by future experiments.

LETTUCE.

The seed germinated on all four of the plots, but the young plants on plot 23, with one or two exceptions, soon died, and the number which survived, even on plot 27, was but few. In

neither case did they make any considerable growth or appear of normal color. It was evident, in other words, that the lettuce plant was equally, if not more susceptible, to the unfavorable soil conditions even on plot 27, where nitrate of soda was used, than were the spinach, beet and sorghum plants, and in this respect it stood in the strongest contrast to the lupines and soja beans which grew best where the soil was decidedly acid and where no lime had been employed. On plots 25 and 29 the heads were tender and succulent and finely developed and the general appearance of the crop was highly satisfactory. The following are the weights of the lettuce, as cut: (*For illustrations see Figs. 33, 34, 35 and 36*).

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Lettuce, weight as cut	0.03	7.63	0.13	10.13

By a comparison of the gains from the use of lime it is as impossible as in the case of the spinach and beets to conclude that the lime had been of benefit so far as concerns the nitrification of the sulphate of ammonia. It is evident that lime was wonderfully beneficial in both instances, and the known acidity of the soil and results with other crops bear out the general conclusion that this action of the lime was due, chiefly, to its overcoming the acidity of the soil and less, if at all, to the direct action of the lime as a manure. We intend to pursue this subject further with the hope of demonstrating conclusively whether or not and in what measure these remarkable results are attributable to the neutralizing action of the lime.

OATS, BARLEY AND RYE.

For the purpose of economizing space and owing to the somewhat similar nature of these cereals, we shall consider them collectively. That the cereals possess some marked individuality has already been shown by Wagner, who found the feeding or dissolving power of the root for potash to vary decidedly, oats

standing at the head of the list and barley at the bottom. In the course of the field observations, the most marked peculiarity noticeable was the following, viz.: the barley withstood, less successfully, the unfavorable conditions on plot 23, than either the rye or the oats, and was apparently much more benefitted by an application of lime than either of the others. Just as the grain was beginning to harden, these crops were very severely beaten down by two heavy storms which followed each other quickly, and in consequence it was deemed advisable, for the sake of securing as reliable data as possible, to harvest the crop at once and to determine the combined weight of straw and grain in its then immature state. The weights of material as harvested and also of absolutely dry material are given in the following table:

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Oats, straw and grain, as harvested	4.44	5.31	5.56	7.50
" " " absolutely dry	2.30	2.84	2.44	3.08
Barley, " " as harvested	0.50	3.94	2.88	5.31
" " " absolutely dry	0.25	2.61	1.77	3.18
Rye, " " as harvested	1.00	2.25	2.13	2.06
" " " absolutely dry	0.45	0.96	1.20	1.36

By a comparison of the yields of dry matter it will be seen that the gain of plot 29 over plot 27 is practically the same as that of plot 25 over plot 23, with the exception of the rye on the sulphate of ammonia plots, 23 and 25, where the difference in gain amounted to .35 of a pound. Thus it will be seen that from the results with these crops, no definite conclusion can be drawn as to a favorable effect of the lime in aiding the nitrification of the sulphate of ammonia. If we assume, however, from the results with previous crops that the nitrogen of the sulphate of ammonia probably became available to the plants, then we are led to believe that the greater yield on plot 29 as compared with plot 25 may have been due to some beneficial action of the soda. The value of lime is very apparent, though this is much more marked in case of the

barley than in case of the oats and rye. It is also evident from the above, as was shown by the field observations, that the barley was less able to withstand the unfavorable conditions on plot 23 than either the oats or rye and that the oats were less severely affected than the others. It is possible that these results may lead to such future investigation as will show why barley does not succeed so well in New England as earlier and how it may be made to succeed again, for observations on soils from many parts of Rhode Island and from several places in Massachusetts indicate their frequent acidity and the probable need of carbonate of lime, in some form.

HUNGARIAN, GOLDEN MILLET, ITALIAN MILLET AND PANICUM CRUS-GALLI.[1]

(For illustrations see Figs. 37, 38, 39 and 40.)

No. of plot	23	25	27	29
	Sul. Ammonia alone. lbs.	Sul. Ammonia + lime. lbs.	Nitrate Soda alone. lbs.	Nitrate Soda + lime. lbs.
Hungarian, green	1.81	10.69	8.75	8.31
" absolutely dry	.74	4.86	4.01	3.66
Golden Millet, green	1.19	16.44	12.63	14.13
" absolutely dry	.35	5.41	4.22	4.39
Italian Millet, green	2.50	21 38	19.56	16.75
" absolutely dry	.86	6.90	6.25	5.46
Panicum crus-galli, green	12.13	41.25	43.06	58.00
" " absolutely dry	3.39	10.65	11.68	15.29

Comparing the yields of dry matter in the above table, it is evident at a glance that the benefit derived from the lime in connection with the sulphate of ammonia was great in every instance, while in connection with nitrate of soda there was a slight loss in two instances, a slight gain in one instance and a decided gain in connection with the Panicum crus-galli. The apparent slight losses in two of the cases may not have been attributable to any ill effect but to the possible slight inequalities in the soil of the

[1] A Japanese forage plant similar to, though much larger, than the ordinary barn-yard grass.

respective plots. Having observed that lime was of no especial assistance, except in one case, in connection with the nitrate of soda, let us now compare the results on plots 25 and 27. It will be seen that, with the exception of the Panicum crus-galli, the yield on plot 25 is greater than on plot 27. In other words, there is no question in this instance as to the especial value of the lime in connection with the sulphate of ammonia and the indications are that this is attributable to its neutralizing action, and its consequent promotion of nitrification. The results with the Panicum crus-galli on plots 27 and 29 indicate the possibility that the Panicum crus-galli stands more in need of lime, on our soil, than the three other plants.

BUCKWHEAT.

The weights of buckwheat represent the yields from three rows. The buckwheat, like the oats and rye, was better able to withstand the unfavorable conditions on plot 23 than most of the other crops, excepting certain of the legumes. This is plainly to be seen from the following table:

No. of plot	23 Sul. Ammonia alone. lbs.	25 Sul. Ammonia + lime. lbs.	27 Nitrate Soda alone. lbs.	29 Nitrate Soda + lime. lbs.
Buckwheat, green	43.38	93.25	66.19	97.19
" absolutely dry	9.35	25.29	14.08	23.19

As will be seen by comparing the above weights of dry material, the gain of plot 25 over plot 23 is decidedly greater than that of plot 29 over plot 27, and the fact of the greater efficiency of the lime in connection with sulphate of ammonia as compared with nitrate of soda is evident. The beneficial effect of the lime on buckwheat, even in connection with nitrate of soda, is also decidedly marked.

GENERAL OBSERVATIONS ON THE FOREGOING EXPERIMENTS.

(EXPERIMENT "C," PAGES 224–249.)

LEGUMINOUS PLANTS OR "NITROGEN GATHERERS."

The common pea and clover were benefitted by an application of lime both in connection with nitrate of soda and sulphate of ammonia, though much more so in case of the latter.

The common white bean, white podded adzuki and cow pea were benefitted by lime in connection with sulphate of ammonia, but in connection with nitrate of soda the lime was of no advantage.

The lupine and soja bean appeared to be positively injured by lime in connection with both sulphate of ammonia and nitrate of soda.

OTHER PLANTS.

The following plants were benefitted by an application of lime in connection with both sulphate of ammonia and nitrate of soda: Indian corn (three varieties), beets (four varieties), carrots (two varieties), Swedish turnips or ruta bagas, sorghum (three varieties), sunflower, kale, spinach, cabbage (early and late), potatoes, tomatoes, lettuce, oats, barley, rye and Panicum crus-galli.

The plants which were benefitted by the lime in connection with the sulphate of ammonia, but which were not helped by lime in connection with nitrate of soda were: Indian corn[1] (one variety), Hungarian, Golden millet and Italian millet. *All of the non-leguminous crops were benefitted by lime in connection with sulphate of ammonia.*

The plants which show a decidedly greater gain from lime in connection with sulphate of ammonia, than in connection with nitrate of soda, and from which it appears that the beneficial effect of the lime was probably due in part to its having aided

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[1] It is possible that this result is attributable to slight inequalities in the soil or to damage from two severe storms.

nitrification, are: common beans and peas, white podded adzuki, carrots, Swedish turnips, sorghum, sunflower, kale, cabbage, potato, tomato, barley, rye, Hungarian, golden millet, Italian millet, panicum crus-galli (from Japan), and buckwheat. The results with oats are so close as to be inconclusive, though the probability is, that upon further experiment it would be found to come within the above list.

The results with *certain* of the plants in this experiment are such that from their consideration alone, it could not be concluded that lime had been of special value in aiding nitrification. These are: soja bean, cow pea, lupine, beets, spinach and lettuce. As stated above, the results with oats were so close that no definite conclusion can be recorded, yet the probability is that further experiment would show that this plant would not come in this list. The first three of these plants are so called "nitrogen gatherers," and in case the bacteria by means of which they acquire atmospheric nitrogen are present in the soil, they are practically independent of the nitrogen which is applied, and can flourish without its aid. They also seem able to thrive on an acid soil, and can resist the effect of the sulphate of ammonia, which was highly injurious to many other plants. The spinach, beets and lettuce were so injuriously affected by the acid condition of the soil (whatever its nature), that the crop was almost a total failure even where nitrate of soda was employed, so that in case of these plants the acidity of the soil was a more important factor than the form of the nitrogen. It is highly interesting to note that had we experimented with these plants only, we could not, without a chemical examination of the forms of nitrogen in the soil, have established the value of the air-slacked lime in aiding nitrification. Wagner and Dorsch worked with peat or muck, which is frequently acid, and grew summer rape only, and they can perhaps be considered fortunate to have hit upon a plant which gave, under the conditions, reliable results, for had they chosen lettuce, spinach or beets, it is *possible* that their results would have been negative, in which case they would have been led to wholly

erroneous conclusions. *It appears, therefore, that our agricultural plants are even more varied in their needs and adaptations than is generally supposed, and that instead of drawing general conclusions as to the value of fertilizers or soils from the results with one plant, we must employ in our experiments every plant to which we desire our results to apply.*

EXPERIMENT "D."

For the purpose of securing more uniform soil conditions than are obtainable in the field, it was decided to test by pot experiments also, the value of air-slacked lime in aiding the nitrification of sulphate of ammonia. For this purpose galvanized iron ash cans served as pots. The pots were 18 inches in diameter and 26 inches deep, with the bottom sloping towards the center, at which point an opening was left. The pots were sunk in the ground some distance apart, and to within two inches of the top with a tile drain below for the purpose of preventing any accumulated water from entering them and thus adding soluble fertilizing ingredients from the surrounding soil. A few cobble stones were put in the bottom of each pot, and upon these 154 pounds of subsoil, which was taken from land adjoining the coöperative acre used for field experiments with fertilizers on Indian corn.[1] The surface or agricultural soil was taken from the 00 plot of the above-mentioned experimental acre, and 100 pounds of this were added to each pot, which was sufficient to bring the soil within the pot about level with that without. This surface soil was already practically exhausted; the land had been in grass, without manure, for some years previous to 1890, and the three following years it had been planted, without manuring, to Indian corn. The subsoil and surface soil were each thoroughly mixed before the pots were filled. Each pot employed in the experiment received an equal amount of phosphoric acid and potash, the former in form of dissolved bone-black at the rate of 1,200 pounds per acre, and the latter in form of muriate of potash at the rate of 400 pounds per

[1] 3d Annual Report, R. I. Agricultural Experiment Station, for 1890, page 80.

acre. With the exception of four pots, each of those above-mentioned, received an equal quantity of nitrogen, either in the form of sulphate of ammonia (20 per cent. nitrogen), or nitrate of soda (15.50 per cent. nitrogen), and to certain of these, plaster (sulphate of lime) or air-slacked lime was also applied. The combinations of nitrogen with lime in the two forms is best made clear by the following:

No. of pots used.	Form of nitrogen.	Amounts of air-slacked lime or land plaster.
2	None.	None.
2	"	Air-slacked lime, 4 tons per acre.
3	Sulphate of ammonia.	None.
3	" " "	Air-slacked lime, 4 tons per acre.
2	" " "	Air-slacked lime, 1 ton per acre.
2	" " "	Land plaster (lime or calcium oxide at same rate as with air-slacked lime at 4 tons per acre.)
2	Nitrate of soda.	None.
2	" " "	Air-slacked lime, 4 tons per acre.

The pots were set in the ground for the purpose of securing normal and uniform conditions of temperature, for upon this the rate of nitrification is considerably dependent. The chief drawback to this method of procedure is that the pots cannot be run under a shelter during storms nor at night, and are liable, in consequence, to become flooded with water and suffer unequally from leaching, owing to the tendency of nitrates to leach more readily than ammonia salts. The plan was considered of having the pots surrounded by soil but connected by rubber tubing with an adjoining ditch, in which vessels could be placed to receive the drainage with the idea of its subsequent return or a determination of the amount and form of nitrogen removed. This plan was necessarily abandoned in consequence of the additional expense involved and on account of the influence of the ditches on the temperature of the surrounding soil and pots.

The value of plaster in aiding nitrification has been frequently claimed[1] and it seemed desirable to test it in this connection. It

[1] Warrington, Jour. Chem. Soc., Vol. XLVII, pp. 760-761, states that it favors the nitrification of urine by reacting upon the carbonate of ammonia, whereby carbonate of lime and sulphate of ammonia result and its alkalinity is reduced.

was not supposed, however, that it could at the outstart fill the place of the air-slacked lime, for the reason that the chief obstacle to nitrification seemed to be the acidity of the soil, which plaster, owing to the fact that its lime is already combined with a strong acid (sulphuric acid), would be unable to neutralize. Whether the plaster will undergo, gradually, such changes that it will prove effective in succeeding years remains to be ascertained. The crude land plaster which we intended to employ in this experiment was found to contain a high percentage of magnesia, while our air-slacked lime contained but a slight amount; for this reason chemically pure plaster was employed so as to put lime in the one form against a like amount in the other form, and not put lime in one case against lime and magnesia in the other. Indian corn was selected for this experiment for the reason that it was upon this crop that the ill-effect of sulphate of ammonia was first noticed. The kernels planted were taken from the central portion of the same ear and were all well developed. Three kernels were planted in each pot, and the stalks were thinned to two as soon as they were large enough to allow of the selection of the most uniform pair. The stalk which was removed was buried in the soil of the pot to which it belonged. Owing to delay in the shipment of the pots, the corn could not be planted until June 8th. On the morning of June 13th the corn in all of the pots was up, with the exception of the two pots which received no manure. On the evening of June 15th the corn in one of the unmanured pots was just visible, and by the following morning that in the other had made its appearance. On June 27th the corn was thinned to two stalks. The pots were kept free from weeds and the hoeing was performed with a hand weeder. On July 11th the corn in the unmanured pots was far behind that in all of the others, that in the pots receiving sulphate of ammonia and gypsum was next poorest, and that fertilized with sulphate of ammonia without lime was but slightly better. At this time the corn in the sulphate of ammonia pots, which received air-slacked lime at the rate of one ton per acre appeared considerably ahead of

that receiving four tons, and it was already far ahead of that to which no air-slacked lime was added. However, some fifteen to seventeen days after the first improvement was visible in the pots where one ton per acre of the lime was used, a similar and sudden improvement became noticeable in the pots where the air-slacked lime was applied at the greater rate. There seems to be every reason to conclude that the sudden improvement in the corn, in the cases where air-slacked lime was applied with sulphate of ammonia, was coincident with, and dependent upon, the beginning of active nitrification. Such being the case, it may seem surprising at first that the nitrification in the case of the larger quantity of lime began more than two weeks later than where one-fourth as much was used. It must be considered, however, that the air-slacked lime was decidedly alkaline, and where the larger quantity was used too great alkalinity was the undoubted cause of the delay, nitrification not beginning until the alkalinity was somewhat reduced by the carbonic acid and other agencies within the soil. In fact, Warrington[1] has already pointed out that "the existence of more than a certain small portion of soluble alkali in a solution, entirely prevented nitrification from taking place." Observations to this effect were made by him with sodium carbonate, ammonium carbonate and urine. An application of gypsum to urine aided its nitrification by reacting upon the carbonate of ammonia present, by which sulphate of ammonia and carbonate of lime were produced and the alkalinity thus lowered. Warrington also states[2] that an alkalinity somewhat above 400 parts of nitrogen per million, as ammonia, does not destroy the nitrifying organism, but merely suspends its action. In our case no great harm resulted from this delay for the reason that the Indian corn still had time to practically complete its growth. In case of crops which mature early or of those which have but a brief period in which to mature, a directly available form of nitrogen should be at immediate disposal. This can, of course, be provided for by the use of

[1] Jour. Chem. Soc., Oct. 1885, Vol. XLVII, pp. 758-761.
[2] Ibid, p. 759.

nitrates, instead of ammonia salts, barnyard manure, or organic nitrogen in form of blood, meat, fish, etc. In case the latter materials are employed, however, the lime might be, and probably for this reason always should be, applied in autumn, so that any possible excess of alkalinity may be neutralized in the soil before the spring application of fertilizers is made. It was quite noticeable that the corn in the pots which received potash, phosphoric acid and air-slacked lime, but no nitrogen, was much superior in the early part of its growing period to that in similarily treated pots which received no lime. In fact for some days it more than held its own with the plants which received both air-slacked lime and sulphate of ammonia. As the season advanced, however, it gradually fell behind the latter, and at the end of the season appeared decidedly inferior.

The crop from each pot was air-dried for a like length of time in the chemical laboratory, the room being heated during the latter portion of the period. The following table shows the results of the experiment:

TABLE SHOWING THE MATERIALS APPLIED, THE POT NUMBER AND THE WEIGHT OF THE PRODUCT.

Muriate of potash was applied at the rate of 400 lbs. per acre or 7.3582 grammes per pot, dissolved boneblack at the rate of 1200 lbs. or 22.0746 grammes per pot, sulphate of ammonia at the rate of 720 lbs. per acre or 13.245 grammes per pot, nitrate of soda at such a rate as to furnish the same amount of nitrogen as the sulphate of ammonia, i. e., 17.0904 grammes per pot, and gypsum or plaster at the rate of 310.702 grammes per pot or at such a rate as to furnish the same amount of lime (calcium oxide) as was applied in the form of air slacked lime at the rate of four tons per acre.

	No. of Pot.	Weights of total Indian corn crop after air-drying seven weeks in the laboratory.		Weights of stover and cobs after air drying seven weeks in the laboratory.		Weights of grain after air-drying seven weeks in the laboratory.	
		Weights from each pot.	Average Weights.	Weights from each pot.	Average Weights.	Weights from each pot.	Average Weights.
		Grammes.	Grammes.	Grammes	Grammes	Grammes.	Grammes.
No Fertilizer	21	2.7	3.9	2.7	3 9	0.0	0.0
	28	5.0		5.0		0.0	
Potash and Phosphoric Acid	20	64.5	66.8	64.5	66.8	0.0	0.0
	27	69.1		69.1		0.0	
Potash, Phosphoric Acid and Air-slacked Lime. (Four tons per acre or 147.164 grammes per pot)	23	117.3	119.1	98.4	93.2	18 9	25.9
	24	120.8		88.0		32.8	
Potash, Phosphoric Acid and Sulphate of Ammonia	16	9.2	12.6	9.2	12.6	0.0	0.0
	18	8.0		8.0		0.0	
	25	20.6		20.6		0.0	
Potash, Phosphoric Acid, Sulphate of Ammonia and Air-slacked Lime. (Four tons per acre or 147.164 grammes per pot)	17	185.7	192.3	142.2	131.0	43.5	61.3
	19	187.8		127.5		60.3	
	26	203.4		123.3		80.1	
Potash, Phosphoric Acid, Sulphate of Ammonia and Air-slacked Lime. (One ton per acre or 36.791 grammes per pot)	15	171.3	187.7	124.5	137.4	46.8	50.4
	22	204.1		150.2		53.9	
Potash, Phosphoric Acid, Sulphate of Ammonia and Gypsum (Sulphate of Lime)	*1	52.9	36.5	46.4	33.2	6.5	3.3
	8	20.0		20.0		0.0	
Potash, Phosphoric Acid and Nitrate of Soda	6	151.5	122.6	141.7	107.2	9.8	15.4
	†13	93.7		72.7		21 0	
Potash, Phosphoric Acid, Nitrate of Soda and Air-slacked Lime. (Four tons per acre or 147.164 grammes per pot)	7	113.0	127.2	78.5	91.2	34.5	36.0
	14	141.3		103.8		37.5	

* One stalk in this pot grew considerably better than the other one and also better than those in No. 8, being the only one to mature even a small ear.

† Both stalks were broken off by the wind above the ears sometime before they reached maturity.

From a careful inspection of the foregoing table it will be seen that the results, though fairly uniform, show here and there considerable variations, which are without doubt due largely to the unequal injury effected by two severe storms which occurred during the latter part of August by which many of the leaves, and in some cases portions of the stalks, were broken or severely twisted. The average product from the two unmanured pots was only 3.9 grammes, while the highest total product from any other pot was 204.1 grammes, so it is evident that the soil was in an extremely exhausted condition. The average product where potash and phosphoric acid (pots 20 and 27) were applied was 66.8 grammes, where nitrogen in form of sulphate of ammonia was added to the potash and phosphoric acid (pots 16, 18 and 25) the yield of total product instead of being increased was reduced to 12.6 grammes, from which it is apparent that the sulphate of ammonia exerted a poisonous action similar to that observed in the field experiments. Where nitrogen in form of nitrate of soda was added to the potash and phosphoric acid the average yield of total product was 122.6 grammes,[1] and the average product of grain 15.4 grammes, and where still further addition of air-slacked lime was made the total product averaged but 127.2 grammes. It should be remarked that the corn in pots 6, 13, 7 and 14 (the nitrate of soda group) suffered more severely from the effects of the storm than any of the others and hence the results are not as uniform nor trustworthy, but if we compare the lowest result without lime (pot 13) with the highest where lime was added (pot 14), we find even then, that the gain due to the lime in this instance is not equal to that shown by the averages of the very uniform weights from pots 20, 27, 23 and 24. This may seem at first surprising, but it must be remembered that pots 6, 13, 7 and 14 had been generously supplied with nitrogen in the form of nitrate of soda, and the nitrifying effect of the lime could not appear in the crop for the reason that whatever nitrates were produced from the soil-nitrogen were superfluous and could

[1] This average is doubtless lower than it should be owing to the injury to the corn in pot 13.

not be utilized. In the case of pots 23 and 24, however, no nitrogen was applied, and the nitrates which were produced from the organic nitrogen of the soil were at once appropriated by the plant. For this reason the gain from the use of lime in its capacity of a direct manure and soil ameliorator is indicated only where it is used in connection with the nitrate of soda, and the results point strongly to the conclusion that the air-slacked lime was effective in pots 23 and 24, by virtue of its having aided the nitrification of the inert nitrogen of the soil. Comparing the ill-effect of the sulphate of ammonia so plainly shown by the yields from pots 16, 18 and 25, with the results as shown by pots 17, 19, 26, 15 and 22, where air-slacked lime in different amounts was used in connection with it, *there seems no escape from the conclusion that the air-slacked lime not only neutralized the ill-effect of the sulphate of ammonia, but that it made possible the transformation of the otherwise poison into a valuable plant food.* This latter fact is plainly to be seen by a comparison of the yields from pots 23 and 24 with those where the lime was applied with the sulphate of ammonia. Comparing the yields where nitrate of soda and air-slacked lime were applied (pots 7 and 14) with those where a like quantity of lime was employed with the same amount of nitrogen in form of sulphate of ammonia (pots 17, 19 and 26), it is seen that the results with the sulphate of ammonia are much better than those with the nitrate of soda. This fact may be due to loss of nitrate of soda by leaching (sulphate of ammonia leaches less readily), or to the fact that the corn in the nitrate of soda pots suffered greater injury from the storms, or perhaps to both causes. It may also be possible that the large amount of *soda* in the nitrate of soda was injurious to the corn plants, though certain plants are claimed to be benefitted by it when applied in moderate quantities. Whatever the cause may have been we cannot believe it to have been due to the fact that the nitrogen was in the *form of a nitrate,* for P. Wagner and Dorsch and others have shown, when the conditions for nitrification are favorable and loss by drainage is prevented, that owing probably to a loss of nitrogen in the nitrifica-

tion of ammonia salts, the same quantity of nitrogen in the form of nitrates is slightly superior to that in sulphate of ammonia. The yields from pots 1 and 8 lack uniformity, yet, considered together with the fact that the plants showed considerable improvement toward the close of the season, it appears that plaster (sulphate of lime) overcame in a slight measure the ill-effect of the sulphate of ammonia, yet taking the most favorable yield, viz., that of pot 1, we find that it was nevertheless inferior to that where potash and phosphoric acid were applied, without nitrogen.

GENERAL SUMMARY OF THE RESULTS OF THE POT EXPERIMENTS "D."

These experiments accord, fully, with the results in the field, and show in the most conclusive manner that the application of nitrogen in the form of sulphate of ammonia, on our soil, is not only without advantage, but that when applied in considerable quantity it almost neutralizes the otherwise good effect of the potash and phosphoric acid applied in connection with it. When air-slacked lime was applied in connection with the sulphate of ammonia and other manures, not only did no injurious effects follow, but the results were excellent and the nitrogen of the ammonia salt came into play as a valuable manure. An application of gypsum or land plaster (sulphate of lime) which supplied the same amount of lime (calcium oxide) as air-slacked lime at the rate of four tons per acre, was only effective in *lessening* the ill-effect of the sulphate of ammonia, and unlike the air-slacked lime was not capable of rendering its nitrogen available to the crop.

EXPERIMENT "E."

This experiment was conducted upon plots formed by a subdivision of plot 15 of the experimental plots, described on page 15 of the Fourth Annual Report of this Station. The four plots under consideration were each 18x30 feet and were separated by paths. They were all fertilized at the same rate, with potash in the form of muriate of potash and phosphoric acid in form of dis-

solved boneblack. Two of the plots received an additional dressing of sulphate of ammonia and the other two of nitrate of soda, in such quantities that an equal amount of nitrogen was applied to each plot. One of the nitrate of soda and one of the sulphate of ammonia plots were given an additional dressing of air-slacked lime at the rate of 5,000 lbs. per acre. The fertilizers were applied on June 15 and Indian corn was first planted, which owing to the ravages of crows was practically destroyed, in consequence of which Swedish turnips or ruta bagas were sown on the 14th of the succeeding month. The following table shows the yields of tops and roots obtained upon the respective plots:

No. of Plot.	KINDS OF FERTILIZERS.	Amount of fertilizers per plot.	Yield of roots per plot.	Yield of tops per plot.
		Lbs.	Lbs.	Lbs.
d I	Muriate of Potash Dissolved Boneblack Nitrate of Soda	2.48 7.44 5.76	69.00	60.25
d II	Muriate of Potash Dissolved Boneblack Nitrate of Soda Air-slacked Lime	2.48 7.44 5.76 63.00	234.50	135.00
a I	Muriate of Potash Dissolved Boneblack Sulphate of Ammonia	2 48 7 44 4.46	45.50	29.25
a II	Muriate of Potash Dissolved Boneblack Sulphate of Ammonia Air-slacked Lime	2.48 7.44 4.46 63.00	201.50	129.00

From a consideration of the weights of the roots only, as shown by the above table, it is seen that the gain from the use of lime was greater in connection with the nitrate of soda than with the sulphate of ammonia. It appears from this that the acidity of the soil was so great, that even with nitrogen in the form of nitrate of

soda, the root was unable to develop to any considerable extent, which fact renders it impossible to draw, by comparison, any definite conclusion as to the action of the lime in aiding the nitrification of the sulphate of ammonia. It will be seen by comparing the relative yields of roots and tops on plots aI and dI that the nitrate of soda produced a remarkable amount of tops as compared with the sulphate of ammonia, the amount being so great, in fact, that when we consider the total weights of roots and tops it appears that the gain in total product (roots and tops) attributable to the lime, was greater in the case of the sulphate of ammonia than in case of the nitrate of soda, upon which ground it might be argued that the extra benefit from the use of lime in connection with the ammonia salt was attributable to its having aided nitrification. From this experiment only we would not, however, feel justified in allowing such a conclusion, but when we consider the results obtained with the same crop under very similar conditions, as described on pages 236–237, it appears probable that the lime did aid the nitrification of the sulphate of ammonia. The fact that the nitrate of soda was applied at a greater rate per acre in this experiment than in that just mentioned, may serve to explain why it produced such an unusual amount of tops. Since there was no plot in this case, to which no nitrogenous manures had been applied, it is impossible to conclude whether or not the sulphate of ammonia on plot aI, had exerted an injurious effect.

SUMMARY OF THE RESULTS OF EXPERIMENT "E."

Though the *preceding* experiments leave it no longer a matter of doubt that air-slacked lime overcomes the occasional ill-effect, and aids the nitrification of ammonia salts in a practical way in the field, *this* experiment does not show in a conclusive manner that such is the case. That it does not show this, appears to be due to the fact that the turnips were so injuriously affected by the acidity of the soil that even nitrogen in form of nitrate of soda was incapable of producing a satisfactory crop until the acidity

was overcome by the lime. Practically the conditions were the same as those in experiment "C" in connection with sorghum, lettuce, spinach and beets, only in a less extreme degree. The results show that on a very acid soil it is highly unprofitable to attempt to grow Swedish turnips until the acidity of the soil has been, by some means, considerably reduced or overcome.

General Summary of the Foregoing Experiments.

In the experiments with Indian corn conducted during 1892 and 1893 on the portion of the Experiment Station's coöperative acre, the sulphate of ammonia when applied without air-slacked lime, acted like a poison, the injurious effects increasing with the amount applied. By the use of air-slacked lime the poisonous action was not only entirely prevented but there was every evidence that the nitrogen of the ammonia salt became a valuable plant food. This latter point was strikingly illustrated in the pot experiments with Indian corn, pages 252–260.

The results of the experiments at Hope Valley, R. I., show that even upon soil where sulphate of ammonia gives good results the first year, its continued use may result in a continual and strongly marked decrease of efficiency as compared with nitrogen in the form of nitrate of soda, and that where such has been the result, the application of air-slacked lime is an effectual remedy. In this experiment we had to deal with a *less manurial effect* of the sulphate of ammonia, instead of with a *poisonous effect*, and for this reason, both nitrate of soda and sulphate of ammonia plots were employed not only with but also without lime. The slight benefit derived from the use of lime with nitrate of soda as compared with that when it was used with sulphate of ammonia, furnishes most conclusive evidence that the lime aided chiefly by facilitating the nitrification of the ammonia salt.

The yields of the thirty-eight (38) miscellaneous crops (pages 224–252), show, without exception, where no air-slacked lime was used, that the sulphate of ammonia was inferior in its action to the nitrate of soda, and in most cases, probably poisonous. On

the other hand, where lime was applied in connection with the two forms of nitrogen, the ill-effect of the sulphate of ammonia was not only overcome, but in case of several crops, the yield from the limed sulphate of ammonia plots even exceeded that where lime was used in connection with the nitrate of soda. With but few exceptions, the results show conclusively that the value of the lime was more due to its overcoming the natural acidity of the soil and the acid tendency of the sulphate of ammonia whereby the nitrogen was changed into a form available to the plant, than to its direct fertilizing value.

In the case of the lupine and soja bean, liming lowered the yield in connection with both forms of nitrogen. The reason for this effect remains to be ascertained. The results with these two, as well as with certain other of the leguminous plants, do not furnish any evidence of the probable nitrifying value of the lime, but this is easily accounted for by the fact that they can, under favorable conditions, utilize the atmospheric nitrogen present in the soil, and are practically independent so far as concerns artificial nitrogenous manures. The other plants which fail to show the nitrifying value of the lime (spinach, lettuce, beets and sorghum), were so seriously affected, doubtless by the acid condition of the soil, that they were unable to flourish without lime, even when the most favorable form of nitrogen was employed, and in consequence they furnish no positive evidence whatever as to its nitrifying function.

These experiments show in the most conclusive manner that certain plants thrive best on the acid soil, (for example the lupine), while others like the lettuce, beets, spinach and sorghum refuse to produce a remunerative crop. The Swedish turnip or ruta baga, though a partial failure on our acid soil succeeds far better than the beet. In fact, by a careful study of the results with the different plants it will be seen that practically all gradations between the two extremes may be found. It appears, therefore, that it is highly imprudent to draw general conclusions for a class of plants, even from one plant of the same class, for among the cereals we

Soja Beans.

Cow Peas.

FIG. 8.

Showing the comparatively uniform growth of two leguminous crops across four plots, two of which were manured with sulphate of ammonia, and two with nitrate of soda—one plot in each case being *with* and one *without* lime.

Fig. 9. Beets.

Sulphate of ammonia *without* lime.

Fig. 10. Beets.

Sulphate of ammonia *with* lime.

Fig. 11. Beets.

Nitrate of soda *without* lime.

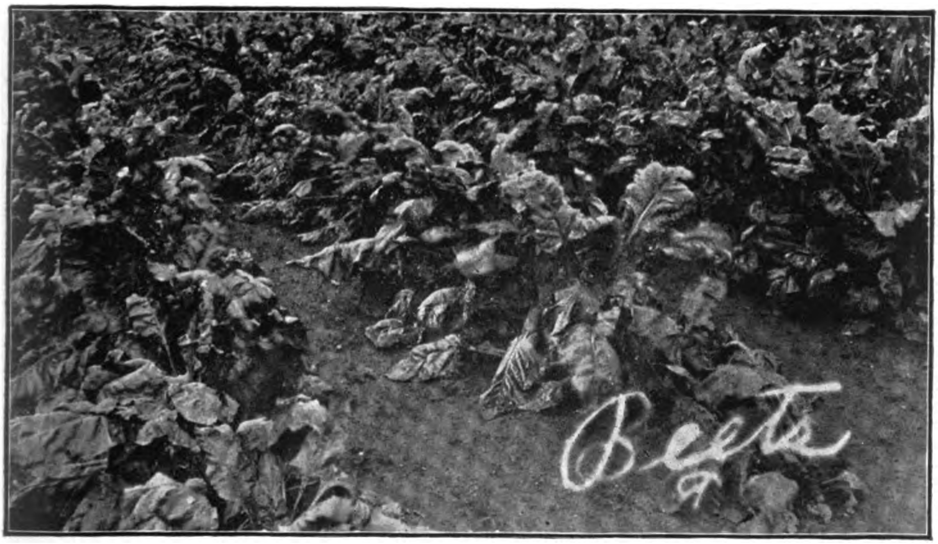


Fig. 12. Beets.

Nitrate of soda *with* lime.

Fig. 13. Carrots.
Sulphate of ammonia *without* lime.

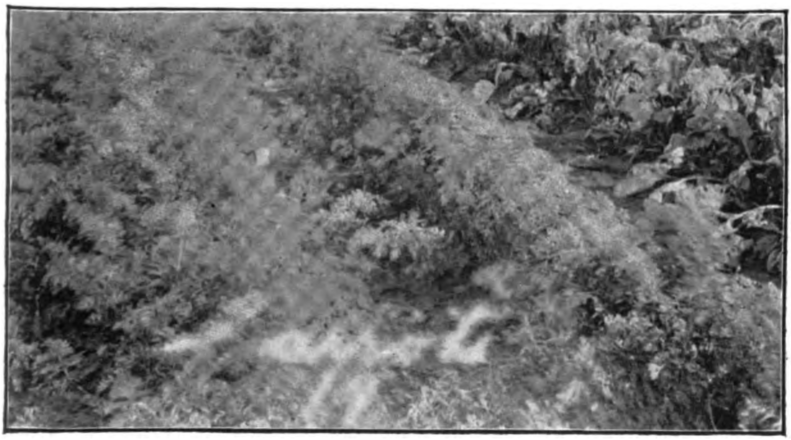


Fig. 14. Carrots.
Sulphate of ammonia *with* lime.

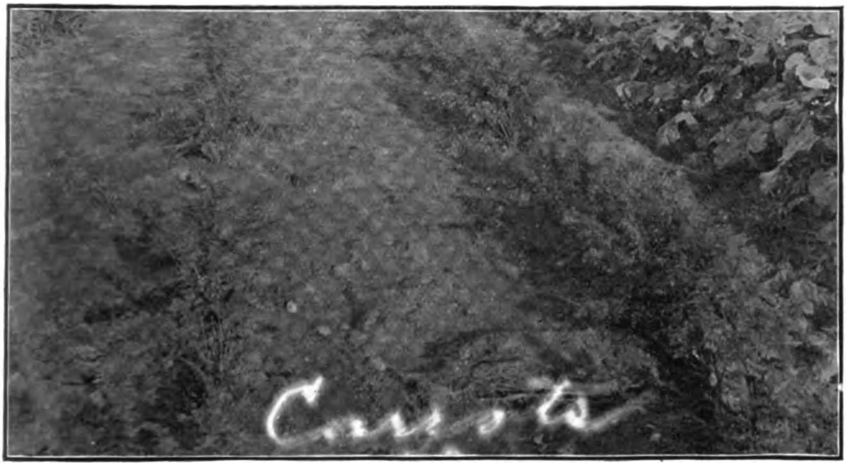


Fig. 15. Carrots.
Nitrate of soda *without* lime.

Fig. 16. Carrots.
Nitrate of soda *with* lime.

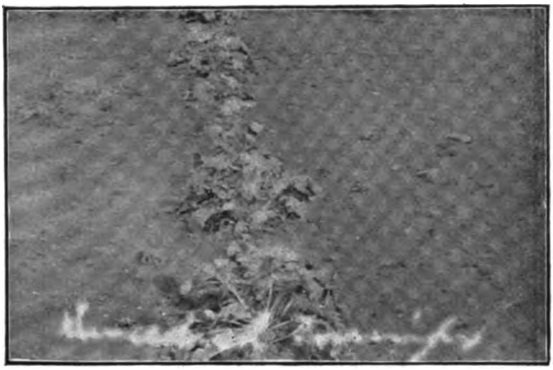


Fig. 17. Rutabagas or Swedish turnips.
Sulphate of ammonia *without* lime.

Fig. 18. Rutabagas or Swedish turnips.
Sulphate of ammonia *with* lime.

FIG. 19. Rutabagas or Swedish turnips.
Nitrate of soda *without* lime.

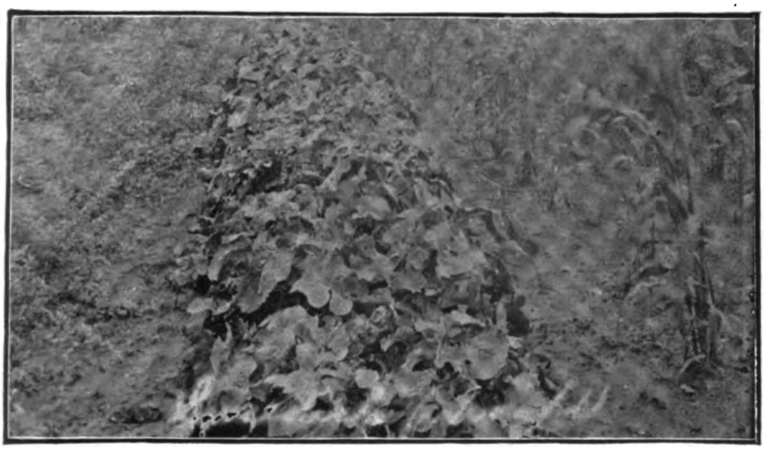


FIG. 20. Rutabagas or Swedish turnips.
Nitrate of soda *with* lime.

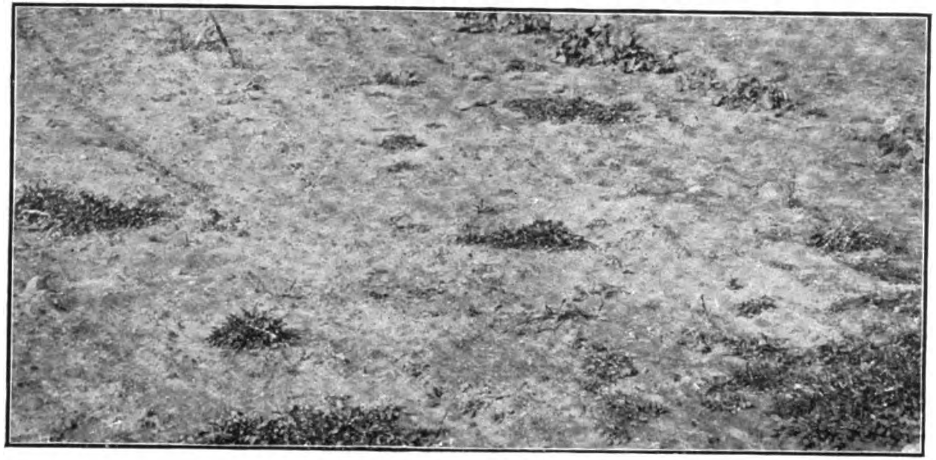


FIG. 21. Kaffir corn and amber sugar-cane.
Sulphate of ammonia *without* lime.

Fig. 22. Kaffir corn and amber sugar-cane.
Sulphate of ammonia *with* lime.

FIG. 23. Kaffir corn and amber sugar-cane.
Nitrate of soda *without* lime.

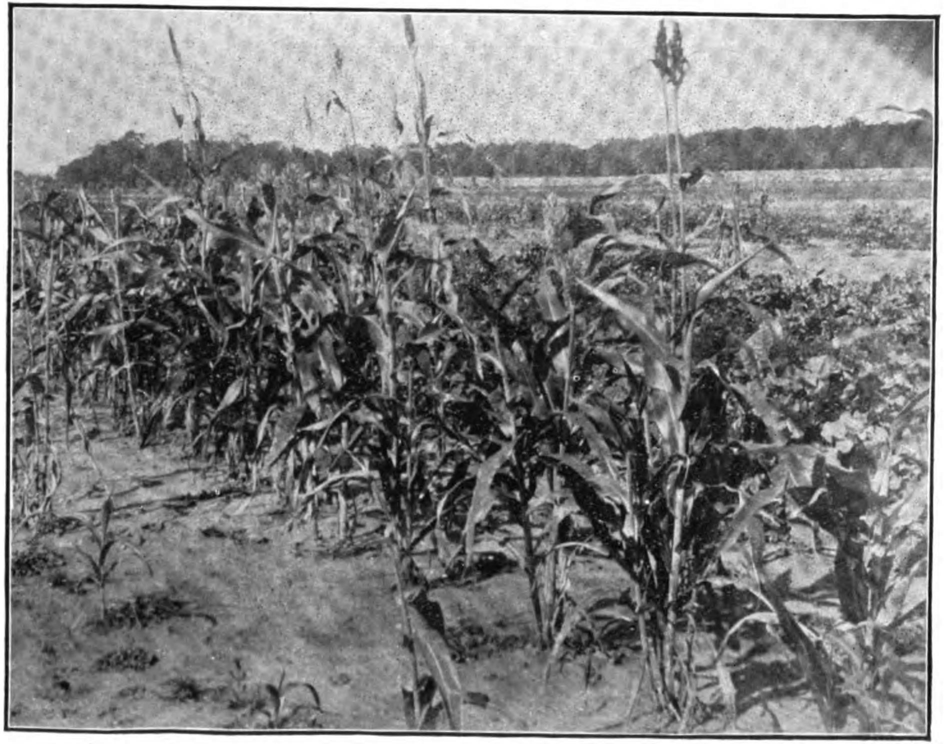


FIG. 24. Kaffir corn and amber sugar-cane.
Nitrate of soda *with* lime.

Fig. 25. Spinach.

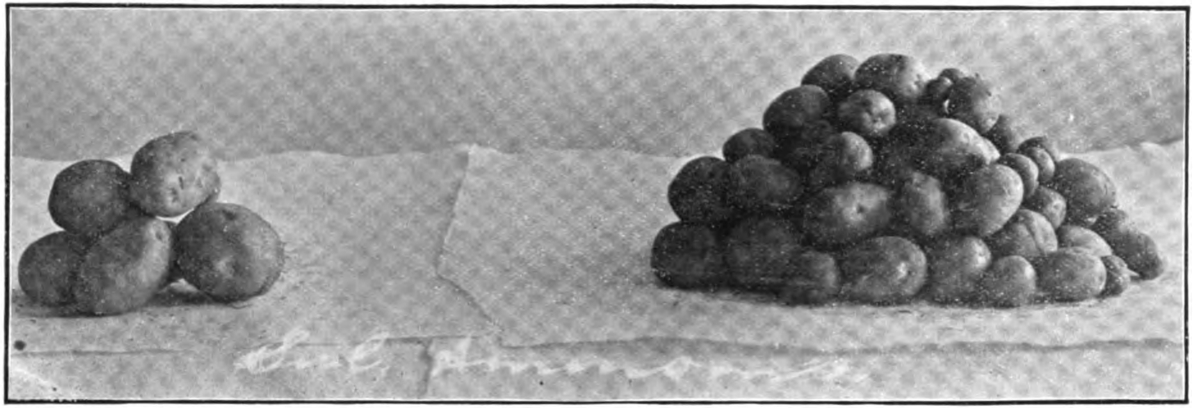
Sulphate of ammonia *without* lime.

Fig. 26. Spinach.

Sulphate of ammonia *with* lime.

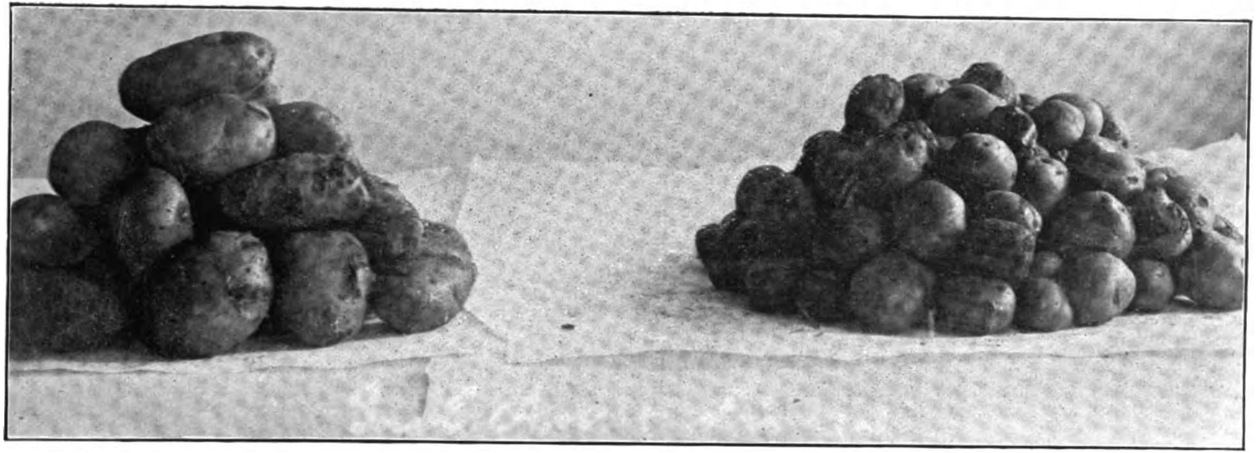
Fig. 27. Spinach.
Nitrate of soda *without* lime.

Fig. 28. Spinach.
Nitrate of soda *with* lime.



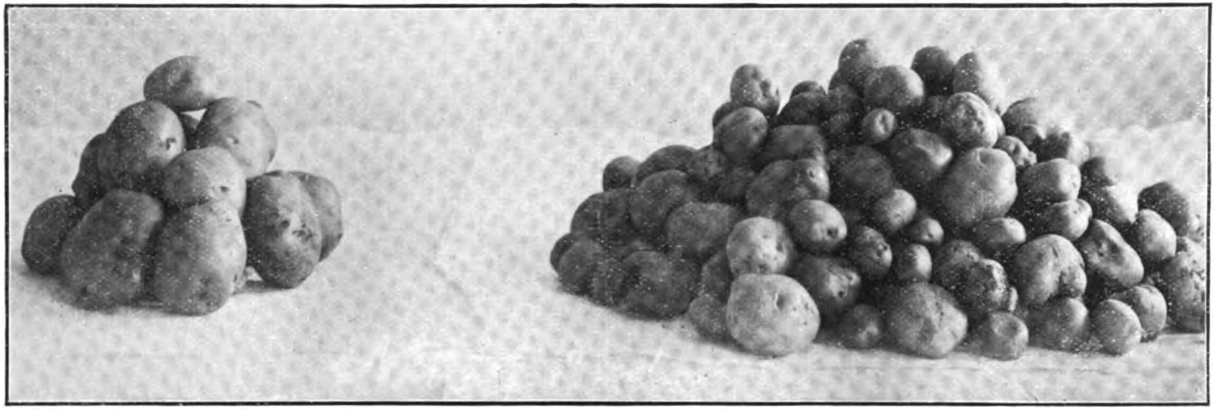
Merchantable. FIG. 29. Potatoes. Unmerchantable.

Sulphate of ammonia *without* lime.



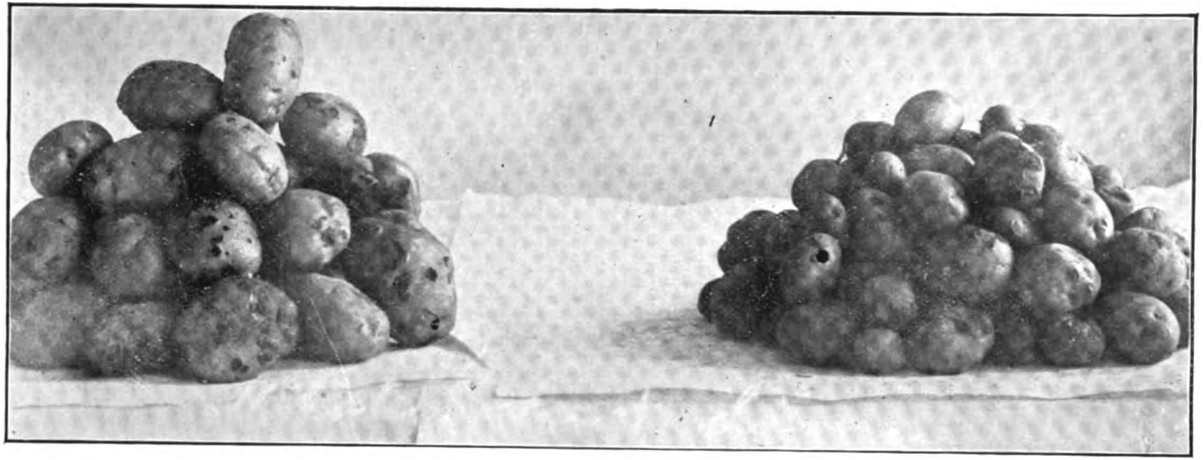
Merchantable. FIG. 30. Potatoes. Unmerchantable.

Sulphate of ammonia *with* lime.



Merchantable. FIG. 31. Potatoes. Unmerchantable.

Nitrate of soda *without* lime.



Merchantable. Unmerchantable.

FIG. 32. Potatoes.
Nitrate of soda *with* lime.

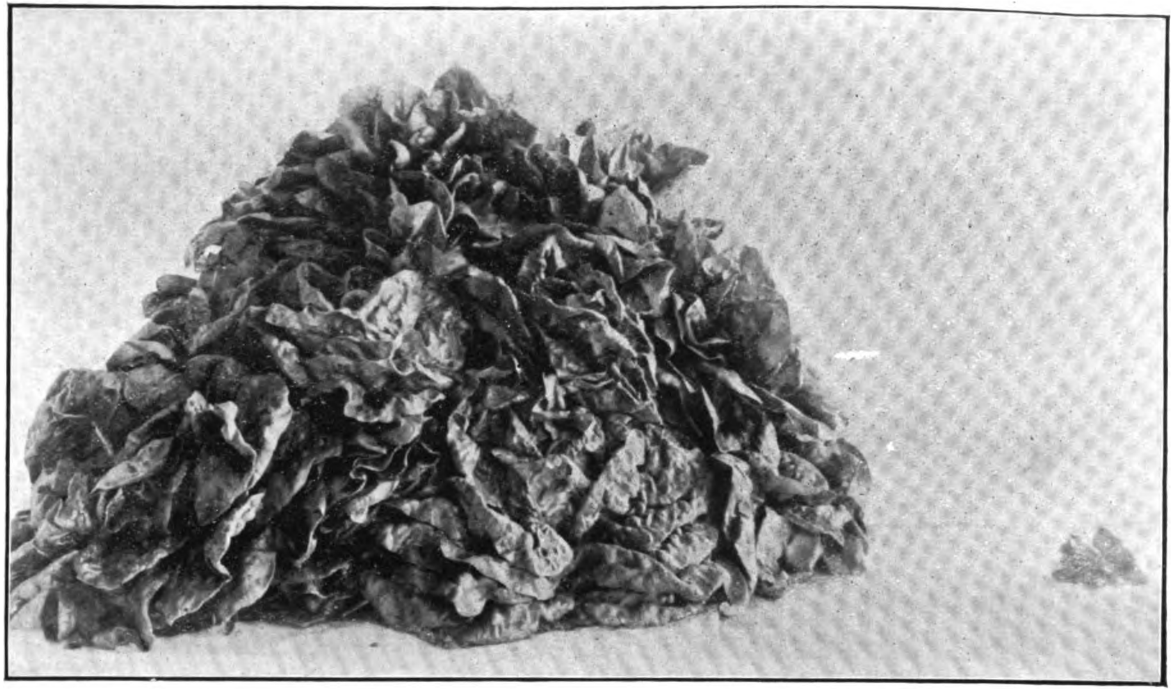


Fig. 34. Lettuce.
Sulphate of ammonia *with* lime.

Fig. 33. Lettuce.
Sulphate of ammonia *without* lime

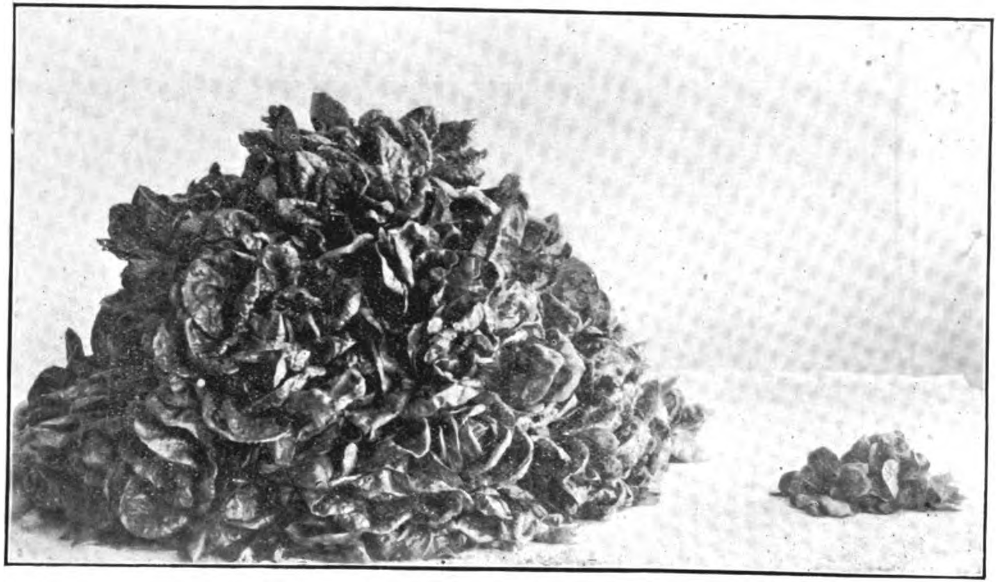


Fig. 36. Lettuce.
Nitrate of soda *with* lime.

Fig. 35. Lettuce.
Nitrate of soda *without* lime.

Panicum crus-galli from Japan (one row).   FIG. 37.   Millet (two rows).

Sulphate of ammonia *without* lime.

Panicum crus-galli from Japan (one row).   FIG. 38.   Millet (two rows).

Sulphate of ammonia *with* lime.

Panicum crus-galli from Japan
(one row).

FIG. 39. Millet (two rows).
Nitrate of soda *without* lime.

Panicum crus-galli from Japan (one row).

FIG. 40. Millet (two rows).

Nitrate of soda *with* lime.

find that barley was less able to withstand the acid soil conditions than the oat and rye, and the variation in the ability of these plants to extract potash and phosphoric acid from the soil has already been demonstrated by Profs. Wagner and Dehérain.

The special experiment with Swedish turnips (pages 260–263) fails to furnish any conclusive data as to the function of the air-slacked lime in aiding nitrification. This is in all probability due to the fact that the acidity of the soil was a more important factor than the form of the nitrogen employed. Though not contributing anything to one of its intended objects, it does show in a most striking and conclusive manner that the loss or perhaps only trifling profit from the growth of Swedish turnips on acid soils may be turned into *handsome profits* by the use of air-slacked lime. It seems probable from these experiments that there has been too great a tendency in our section, and perhaps throughout the country generally, to consider phosphoric acid, potash and nitrogen as the only materials which it is necessary to supply artificially. Indeed, it is possible that in some sections an application of magnesia or compounds containing even other elements, may be found profitable. In fact it appears that the indirect effect of fertilizing materials may, *under certain circumstances*, be of vastly more importance than their direct fertilizing action, though we do not, as claimed by Whitney,[1] believe this to be be generally the case.

PRACTICAL SUGGESTIONS ON THE USE OF LIME.

If a soil is free from, or but slightly acid, the application of air-slacked lime should be small, for otherwise in case of drought there might be danger of loss of ammonia from the soil or by producing too great alkalinity, nitrification would be hindered. For the latter reason it would doubtless be safer to apply the lime in the autumn so that any excess of caustic lime might be changed to the carbonate before the spring application of fer-

[1] Bulletin 21, Md. Agr'l Exp't Station, p. 58.

tilizers. On our soil 2½ tons of air-slacked lime per acre has not proved to be too much, and in one experiment with sulphate of ammonia, on a small scale, a total amount of over 8 tons of lime per acre was used with splendid results in the two successive annual applications. This large amount will probably suffice for a long period of years. In the pot experiments *where the lime was thoroughly mixed with the soil,* one ton per acre gave almost as good results *the first year* as four tons. The smaller the amount used, the more frequent must be the application. Some practical farmers believe that no benefit is derived from lime the first year, but our results entirely controvert such an idea. On an acid soil it is of the utmost importance that at the first application the lime *be as intimately mixed with the soil as possible* and after being spread upon the furrows it cannot be too thoroughly harrowed in. Too little attention to this important point is perhaps the reason for the idea that it is without effect the first season. In general, lime works downward in the soil and passes away gradually in the drainage waters in various combinations. For this reason it is generally recommended to keep it near the surface, rather than plow it in. On soils of granitic origin and others which lack lime and have a tendency to become acid, it would, doubtless, be a wise policy to resort to systematic liming at intervals of a few years. The application of lime on our soils has enabled us to secure a good catch of clover where it was before impossible. It must be borne in mind that the use of lime on potato fields tends to produce a scabby product, provided the scab germs are already in the soil or are introduced in the fertilizers, on the implements of tillage or on the seed tubers. It is to be hoped, however, that if the soil is uncontaminated, the seed tubers can, by a treatment with corrosive sublimate[1] solution, be freed of the disease germs, in which case the liming of potato fields can be resorted to with impunity. We are preparing to test these questions in a complete manner. From our pot experiments it appears that on our

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[1] Bull. 21, R. I. Ag'l Exp't Station, p. 155.

acid soils the same amount of lime (calcium oxide) when in form of land plaster or gypsum (sulphate of lime) is incapable, at least the first season, and perhaps even in succeeding years, of aiding the nitrification of sulphate of ammonia to a practical extent.

We find various references in our American literature to acid soils, and *such soils are generally conceived to be extremely wet*, if not actual peat or muck swamps. We have, however, tested many soils from our own State and also from other sections of New England, and find that even the best drained lands are frequently quite acid, from which it would appear that this condition prevails to an unexpected extent, though not everywhere to an extreme degree, and that a more general use of lime in its caustic state or as carbonate or air-slacked lime would be found beneficial to our agriculture. Wood ashes are abundantly able to perform the same service, but their market price is so high that air-slacked lime at fifty cents per barrel is probably far more economical; this is especially true when we consider the fact that a much greater quantity of ashes must be used to produce the same result and that the extra cost of transportation and application would be considerable.

ON THE EFFECT OF AIR-SLACKED LIME WHEN USED IN CONNECTION WITH CERTAIN FORMS OF ORGANIC NITROGEN.

H. J. WHEELER AND J. D. TOWAR.

In another place[1] we call attention to the value of air-slacked lime in preventing the injurious action of, and in increasing the effectiveness of nitrogen in form of sulphate of ammonia, and it seemed probable that the use of lime in connection with organic nitrogenous fertilizers might also prove of *unusual* value on our

[1] See this report, p. 206.

acid soil.[1] Accordingly it was decided to test the matter by both field and pot experiments. The pots and soil employed were of the same kind as those described on page 252 of this report, the general arrangement being the same in every respect. Each pot received like amounts of potash as muriate of potash, and phosphoric acid as dissolved boneblack. The amount of nitrogen applied to each was identical, irrespective of its form. The nitrogenous materials were dried blood, containing 12.45 per cent. of nitrogen, and "Pennsylvania" tankage containing 8.9 per cent. This tankage consisted of some form of treated leather mixed with material resembling a product obtained in the treatment of city garbage by the "Simonin" process. For the purpose of securing data as to the probable value of lime in aiding nitrification, nitrogen in the form of nitrate of soda was also employed in the test. Three groups of four pots each were included in this experiment; each group receiving one of the above-mentioned forms of nitrogen. Two pots in each group received in addition 147.2 grammes of air-slacked lime or the equivalent of four tons per acre. After the fertilizing materials, including the lime, had been intimately mixed with the surface soil, three kernels of Indian corn (maize) were planted in each pot. As soon as was advisable the poorest plant in each pot was removed, two only being allowed to mature. The results though not as uniform as desirable owing to the unequal damage to leaves and stalks, occasioned by two severe storms which occurred late in the season, are nevertheless of interest. The following weights are those obtained after air-drying for some weeks in the laboratory:

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[1] A. Muntz and A. C. Girard, (Annales Agron. 17, 1891, p. 299), in experiments with an acid soil, from Brittany, found that barnyard manure and lupine underwent nitrification, while sulphate of ammonia and various forms of organic nitrogen did not, and attribute the nitrification of the lupine to the fact that it contained considerable quantities of lime. The lime, to be sure, is at the outstart in combination with organic materials, but by its natural decomposition in the soil it eventually changes into nitrates and carbonates. The manure was claimed to have favored nitrification on account of its own alkalinity, produced by the bicarbonates of ammonia and potash which it contains, and to the lime in organic combinations in the undigested plant residue of which the solid excrement largely consists. They further state that the same effects are produced in case of certain granitic soils, poor in lime, like that of Limousin, and that nitrification is only produced when the manures are sufficiently alkaline or when lime is introduced.

PENNSYLVANIA TANKAGE GROUP.	LIMED.		UNLIMED.	
	Total Crop. Grammes.	Kernels. Grammes.	Total Crop. Grammes.	Kernels. Grammes.
No. of Plot.				
2	....	....	91.3	13.1
9	....		118.7	6.5
3	175.3	60.9	....	....
7	180.6	69.5	....	....
DRIED BLOOD GROUP.				
4	....	....	123.6	39.1
11	....	...	89.1*	0.0
5	152.7	56.0	...	....
12	124.6	46.6	....	....
NITRATE OF SODA GROUP.				
6	....	...	151.5	9.8
13	...	....	93.7	21.0
7	113.0	34.5	....	...
14	141.3	37.2	....	....

The gain from the use of lime in connection with the "Pennsylvania tankage" was very noticeable throughout the season and is plainly indicated by the final weights. From frequent observations during the period of growth it did not, however, appear that the blood was benefitted by the lime to a like extent. The unfortunate injury to the plants in pots 11 and 13 renders the results from the dried blood and nitrate of soda groups somewhat inconclusive, yet it will be seen that the highest total yield from either of the limed nitrate of soda pots does not exceed that of the nitrate of soda pot (No. 6) which was unlimed. By a comparison of the yield from unlimed pot 4, with even the highest yield from the limed pots of the dried blood group, we find that the maximum gain which might be attributed to the lime in this instance does not equal the maximum gain represented in the "Pennsylvania tankage" group.

Some of the foregoing results are, for reasons already stated, unsatisfactory and of themselves inconclusive, yet they are worthy

* The tops of both stalks on No. 13 were broken off by the storms sometime before harvesting, and one stalk in pot 11 was nearly broken off at the base at the same time.

of further examination in connection with the results of the field tests which we will now consider.

EXPERIMENTS IN THE FIELD.

Both field and pot experiments were conducted with the idea that one would serve as a check upon the other. The plots employed for this field experiment were 18 x 30 feet and separated from one another by paths.

Muriate of potash and dissolved bone black supplied potash and phosphoric acid at the same rate to all of the plots, the former being applied at the rate of 400 pounds and the latter at the rate of 1200 pounds per acre. The nitrogen, in each form, was applied to each plot at a rate equivalent to 720 pounds of sulphate of ammonia (containing 20.5 per cent. of nitrogen) per acre. Six plots were employed, two receiving nitrogen in form of "Pennsylvania tankage," two in form of dried blood and two in form of nitrate of soda. One plot of each pair received an additional dressing of air-slacked lime at the rate of 2½ tons per acre.

Indian corn, which was first planted upon the plots, was destroyed by crows, and as it was already late in the season ruta bagas or Swedish turnips were substituted for the corn.

The following shows the yields of ruta bagas from the limed and unlimed plots of each group:

	No. of Plot.	Limed.		No. of Plot.	Unlimed.	
		Roots.	Tops.		Roots.	Tops.
		Lbs.	Lbs.		Lbs.	Lbs.
"Pennsylvania tankage" plots.......	c 2	201.5	103.5	c 1	81.5	46.3
Dried blood plots....................	b 2	196.5	107.8	b 1	119.3	67.5
Nitrate of soda plots................	d 2	234.5	135.0	d 1	69.0	60 3

As will be seen by the foregoing table, the dried blood gave, on the unlimed plots, 37.8 pounds more of roots and 21.2 pounds

more of tops than the "Pennsylvania tankage," but where both were used in connection with lime the yields were practically the same. It should be noted here, that the dried blood was neutral or slightly alkaline, while the tankage gave an acid reaction, and to this circumstance, which was unfavorable to its nitrification, may be reasonably attributed the inferior action of the tankage on the unlimed plots. Leaving out of consideration, as we should, the yield from No. 11 in the pot experiment with Indian corn,[1] it will be observed that the results of the two experiments are practically in accord, both showing that the blood produced better results than the "Pennsylvania tankage" when employed without lime, but that when employed with lime the "Pennsylvania tankage" was fully equal, if not superior, to the blood.

From the pot experiments with Indian corn it did not appear that lime had been of decided benefit when used in connection with nitrate of soda, but in the plot experiment with ruta bagas the beneficial action of lime in connection with the nitrate was extremely marked. This striking difference in the action of lime in connection with nitrate of soda on ruta bagas and Indian corn finds its probable explanation in the idea that the latter was much better able to thrive on the acid soil than the former. The Indian corn not being seriously affected by the degree of soil acidity which existed, was capable of utilizing the nitrate nitrogen which was placed at its disposal, but in the case of the ruta bagas no amount of available nitrogen could be profitably utilized by the plant until the conditions for root development were rendered possible by the neutralizing action of the lime. For the above-mentioned reason the results with ruta bagas fail to show the action of lime in rendering available the organic nitrogen of the blood and "Pennsylvania tankage." The fact that the lime was of little or no benefit *in connection with nitrate of soda* in the pot experiment with Indian corn furnishes very conclusive evidence of the fact that the latter was not seriously affected by the soil

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[1] See pages 267-270.

acidity and consequently we are forced to the conclusion that the beneficial action of the lime in connection with the organic forms of nitrogen as shown by the pot experiments must have been due to its having aided in the transformation of their nitrogen into nitrates. The beneficial action of the lime in the same connection in the experiment with ruta bagas is therefore doubtless attributable to two causes, viz., to its direct neutralizing action and to its having thereby aided nitrification.

CHEMICAL DIVISION.

H. J. WHEELER.

The scope of the work of the Chemical Division has been much enlarged during the past year, owing to coöperation with the Agricultural Division in the carrying out of field and pot experiments. The result of this coöperation has been, not to lessen in any way the duties of those in charge of that division, but rather to increase the total volume of experimental work. Considerable time was consumed in the early part of the year in completing the analyses and in preparing and forwarding the soils and various refuse materials which were contributed by this Division to the Agricultural Experiment Stations' exhibit at the World's Columbian Exposition at Chicago.

One hundred and five brands of fertilizing materials were collected and analyzed during the year in connection with the State Fertilizer Inspection. The results of these analyses together with comments thereon and a general summary of their showing for the year have been prepared for publication, and are embodied in Bulletins 23, 24 and 26. The latter Bulletin also contains an article on the potato scab, issued in connection with Mr. J. D. Towar, assistant agriculturist.

Considerable analytical work has been done for the agricultural and other divisions, and in connection with the field and pot experiments which were conducted conjointly by the Agricultural and Chemical Divisions. The balance of the chemical work has been the analyses of waters and fertilizing materials of various descriptions which have been forwarded for examination, and in preliminary investigation of soils relative to their acidity. A por-

tion of these analyses is to be found under the head of "miscellaneous" analyses, in Bulletin 23, and the balance, excepting such as were made in connection with the experimental work of the station and which will appear in their proper connection, is included in this report.

The number of applications to this Division for information on various topics has decidedly increased, and makes the labor of correspondence not an inconsiderable one.

What was said in my last report in relation to the need of more laboratory space has received additional emphasis through the increased demands made upon this Division.

I consider the Station fortunate in having retained the services of Mr. B. L. Hartwell during the past year. His interest in everything which pertains to the welfare of the Station, and his care in executing whatever is entrusted to him, has done much to give the work of the Divison whatever of value it may possess.

MISCELLANEOUS ANALYSES.

150. Tankage or Animal Dust. This material was used in connection with muriate of potash and other chemicals in certain field experiments conducted at the Station in 1893. It consists of meat, bone and a small quantity of blood. Owing to its having been subjected to steam pressure for some hours the bone is quite soft and friable. Purchasers should demand that the material be finely ground.

	Per cent.
Water	13.72
Phosphoric Acid	14.28
Nitrogen	5 34

151. Dissolved South Carolina Rock. This material was used by the Station in field experiments in 1893.

	Per cent.
Water	9.83
Soluble Phosphoric Acid	13.24
Reverted " "	2.75
Insoluble " "	0.64
Total " "	16.63

152. High Grade Sulphate of Potash. To be used by the Station in 1894. Purchasers of this material should be on their guard, for certain dealers are offering the "Double Sulphate of Potash and Magnesia" which contains but about 27 per cent. of potash, under the name of "High grade" sulphate of potash.

	Per cent.
Water	2.36
Potash (Potassium Oxide)	48.17

153. Residuum from the washings of old rubber boots and shoes which had been treated with potash and vitriol to separate the rubber from the felt linings, etc. Sent by N. N. Cole, Bristol, R. I. This sample possessed but slight fertilizing value, and consisted chiefly of water, rubber and sand.

154. Fertilizer made from 800 lbs. of cotton-seed meal and 1200 lbs. of cotton-hull ashes. Sent by Benj. F. Smith, Pawtucket, R. I.

155. Wood ashes sent by S. B. Champlin & Son, 74 Chestnut St., Providence, R. I.

	153	154	155
	Per cent.	Per cent.	Per cent.
Water	12.98	9 69	13.13
Phosphoric Acid	trace	3.73	1.33
Potash (Potassium Oxide)	0.03	9.00	5.24
Nitrogen	0.18	4.80	...

156. Acme Crude Plaster from Lone Star Plaster Co., Quanah, Texas. Sent by Starkweather & Williams, 25 Exchange Place, Providence, R. I.

	Per cent.
Water	12.57
Lime (Calcium Oxide)	31.18
Potash (Potassium Oxide)	2.46
Sulphuric Acid (SO_3)	41.26
Carbonic Acid (CO_2)	1.10

157. Residuum from indigo dye vats at the Clyde Print Works. Sent by H. L. Greene, River Point, R. I.

	Per cent.
Loss by drying at 100° C	27.34
" " ignition	33.73
Silica	11.56
Lime (Calcium Oxide)	21 31
Iron Oxide ($Fe_2 O_3$)	9.44
Carbonic Acid ($C O_2$)	14.41
Sulphuric Acid ($S O_3$)	2.70
Nitrogen	0.22
Phosphoric Acid	trace.

Reaction decidedly alkaline.

ANALYSES OF WATER SENT FOR EXAMINATION.

(Parts per million.)

No.	Party sending, and locality.	Date of Analysis.	Actual Ammonia	Albuminoid Ammonia.	Chlorine.	Remarks.
158	H. H. Huntington, Newport..	Sept.	0.01	0.02	18.0	Good.[1]
159	G. W. Madison, E. Greenwich.	Nov. 22	0.10	0.16	10.0	Suspicious.[2]
160	E. W. Fiske, Cumberland Hill, (well water)	Dec. 18	0.04	0.03	4.50	Good.
161	E. W. Fiske, Cumberland Hill, (spring water)	Dec. 18	0 15	0.06	4 50	Bad.
162	H. P. Wood, East Greenwich.	Dec. 18	0.04	0.03	78.00	Good.[1]

[1] The high chlorine in these samples was doubtless due to the close proximity of the ocean and the presence of salt from that source, and not to sewage contamination.

[2] The considerable amount of both forms of ammonia, with rather low chlorine, indicates contamination with organic matter, and we are informed that moss was put in the bottom of the well to keep out quicksand, to which the ammonia is doubtless attributable. *A first-class water should not contain so much ammonia*, but the fact that the contamination is of *vegetable* origin renders it less objectionable and dangerous than otherwise.

HORTICULTURAL DIVISION.

L. F. KINNEY.

APPLYING LIQUID MANURE WITH HYDRANT WATER.

A new method has recently been developed by means of which liquid manures can be mixed with the water from the water pipes within ordinary three-fourth inch garden hose, and caused to flow through the hose by the force imparted to it by the water with which it is mixed. By this method liquid manures can be easily applied to plants in the greenhouse or at any point within reach of the hose at the rate of five to ten gallons per minute by one man. The process is as follows: A brass casting (which is known as the "Kinney Pump") is coupled to the hose at any convenient point, or it may be attached to a faucet. To the end of this one or more lengths of three-fourth inch garden hose is attached. At the side of the casting another piece of three-quarter inch hose long enough to reach into the manure tank or cask is also attached. When the faucet is opened the water in passing through the casting forms a partial vacuum in a chamber within, the liquid manure from the tank rushes up through the side hose into the chamber where it comes in contact with the water, a portion of the liquid manure in the chamber adheres to the jet of water and is carried along with it into the hose. More liquid manure takes its place and is likewise carried away, thus a current is formed and the liquid manure flows steadily up from the tank and into the hose, where under ordinary conditions it is mixed with about an equal volume of water. If the suction hose is twenty-five feet or

more long or the passage of the liquid is in any way impeded a smaller proportion of the fertilizer may enter the hose.

The final strength of the solution may, however, be regulated either by placing a diaphragm in the side opening of the casting or by making the solution in the tank more or less concentrated. When coarse material is used in making the liquid fertilizer to be applied by this method a sufficiently clear solution may be obtained to prevent the possible clogging of the suction hose, by placing a well-weighted, close-fitting cover over the material when it is first placed in the cask or tank, and then introducing the water at the bottom of the receptacle and forcing it up through the manure, where it can be drawn off above the cover.

Fig. 1 is from a photograph of the pump.

Fig. 2 is from a photograph of two pumps attached to hose, one of which is used for applying liquid manure and the other insecticides or fungicides.

NEW VARIETIES OF STRAWBERRIES.

Only two of the newer varieties of strawberries that have yet been thoroughly tested here have developed any special merit upon these grounds. These are the Lady Rusk and Number 24, descriptions of which have been given in Bulletin No. 22, of this Station, pages 46 and 47. It is not probable that either of these will ever become standard varieties, yet they have proved superior varieties here. The Lady Rusk is remarkably productive, and the fruit is of fair size and quality. The Number 24 is also productive and the fruit is of the largest size and ripens with the Gandy or late in the season. In many localities the foliage of the Lady Rusk plants has blighted so badly that it has been pronounced worthless. The leaves have not blighted here. But little is yet known concerning the adaptability of the Number 24 to soils, etc., excepting in a few localities. In order that these kinds should be grown in other parts of the State, two hundred and twelve packages of these, with some other plants, have been distributed during the year to citizens of the State in accordance with the

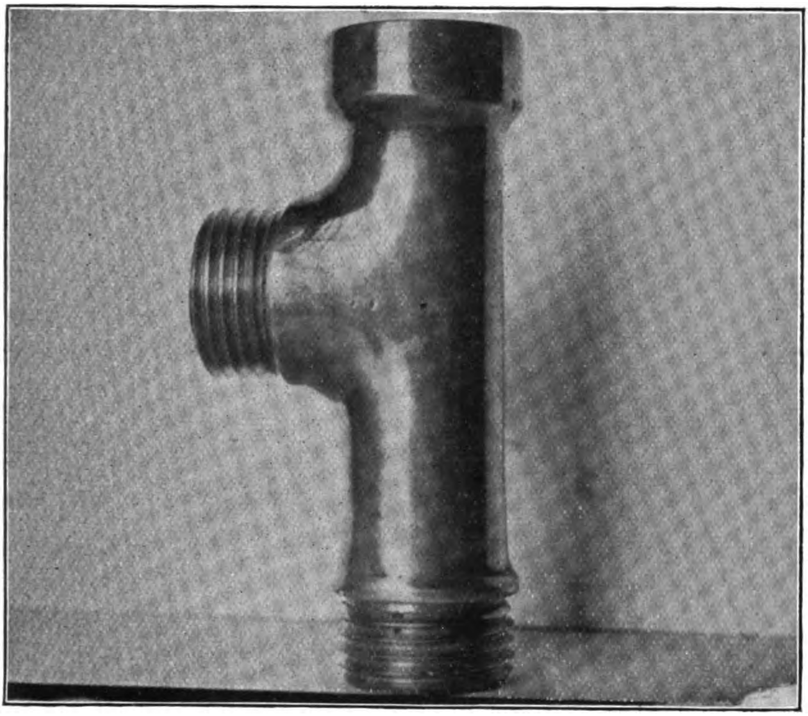


Fig. 1.

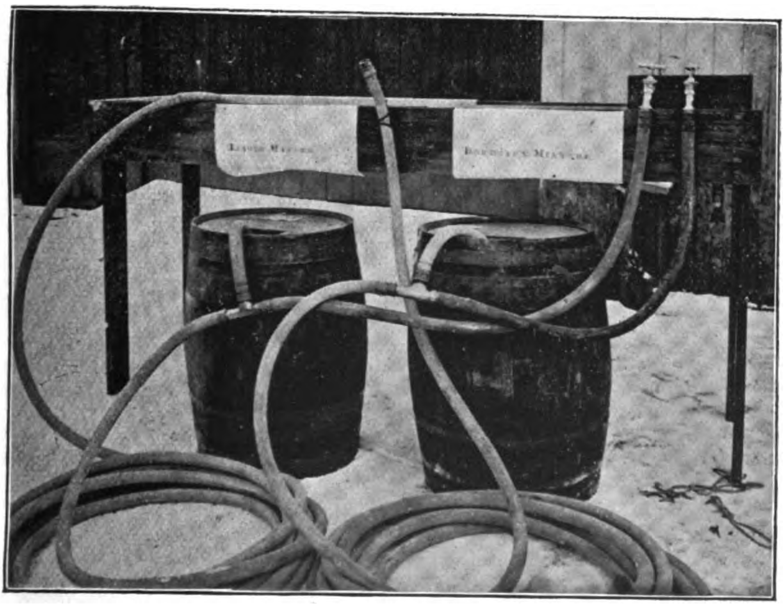


Fig. 2.

conditions mentioned in Bulletin No. 22 of this Station, page 57.

EXAMINATION OF SEEDS.

Apparatus consisting of a seed germinator with porous clay sprouting cups, designed after those used at the Seed Control Station at Zurich, Switzerland, and delicate scales for the determination of the percentages of impurities have been provided. A number of preliminary examinations of samples of seeds obtained of different dealers have been made during the year. While it is yet too soon to report the results of these examinations, two facts may be mentioned. 1st—That the percentage of seeds that had the power of germination when placed under favorable circumstances was smaller in several of the samples than the European standard for that kind of seeds. 2d—That the percentages of weed seed found in some of the samples of grass seed was too large. It appears quite evident that further examinations of samples of grass and grain seeds will prove that some of the most noxious of weeds are being rapidly introduced into our meadows as the result of using seeds which have been carelessly grown.

THE AMERICAN WILD TURKEY. (MALE.)

POULTRY DIVISION.

SAMUEL CUSHMAN.

EXPERIMENTS WITH TURKEYS (TWO SEASONS.)

Early in 1892, the Poultry Division was authorized to attempt to aid the turkey industry of the State, and investigations were at once made to learn the cause of the decline in the production of Rhode Island turkeys. A wild gobbler was procured from Maryland, and an attempt made to cross him with domestic turkeys, that vigorous stock might be secured for distribution about the State, but we were unsuccessful the first season. A lot of turkeys were reared from domestic stock, however, and experiments were carried on with them. A shed built for turkeys was used for roosting quarters with unsatisfactory results, and the effect of confinement and different foods on young turkeys was also studied. Our success in raising them was no greater than that of others in this neighborhood, 50 per cent. of young and old being lost, but considerable was learned. Early in 1893 several wild cross gobblers were bought in the West, and arrangements were made with successful turkey raisers in this State to breed from them and supply the Poultry Division with as many of the best of their progeny as might be required for distribution for breeding purposes. Another attempt was also made to breed the wild gobbler with Rhode Island and Western bronze hens, this time with success. The half-wild young were found to be active, hardy and unusually heavy

and firm in flesh. They were fed differently from those raised the first season, and few were lost. Bulletin No. 25, on "the Production of Turkeys," published in September, 1893, gives a detailed account of experiments carried on for two seasons, the methods followed by various successful Rhode Island turkey raisers, and much information relating to wild turkeys and their crosses, with illustrations. As the edition of this Bulletin, with the exception of a few copies reserved for libraries and public institutions, is exhausted, the illustrations used therein are here reproduced.

DISTRIBUTION OF WILD CROSS BREEDING STOCK.

A large number of three-eighths and one-quarter wild turkeys having been reared for this purpose, the Poultry Division offered in the Bulletin mentioned, (No. 25) to furnish farmers of the State with these birds at about what they cost the Station. Although not as many improved this opportunity as could have been desired, enough have been disposed of to pretty thoroughly distribute this blood about the State, and it will doubtless have a pronounced and lasting effect upon the turkey stock. That it will have anything but a beneficial effect we do not think possible, unless the turkeys are so bred as to make the proportion of wild blood greater than one fourth. In that case they may be wilder and smaller than is desired for practical purposes. Mr. Tucker of Prudence Island, reared last season, three hundred turkeys from three-quarter wild gobblers furnished by the Station, and assures us that while these three-eighths-wild birds were not as tame, he was able to manage them all right, and that of those that hatched, more lived than of any other lot that he has ever had, and they were larger, more uniform in size, ate heartier, fatted quicker and were plumper and handsomer when dressed. An exhibit of young half-wild and three-eighths-wild turkeys was made at the Washington County and State Fairs, and at the winter Poultry Show of the R. I. Poultry Association.

Wild cross birds have been disposed of as follows:

Abbott Run	Capt. N. W. Sutton	1	three-eighths wild gobbler.
Block Island	John Hayes	1	" " " "
" "	Wm. P. Lewis	1	half wild bronze cross gobbler.
Bristol	C. H. Coggeshall	1	" " " " "
Bristol Ferry	Wm. A. Chase	1	three-eighths wild gobbler.
Carolina	A. E. Brown	1	" " " "
Centredale	Wm. A. Sweet	1	" " " "
Charlestown	Perry G. Hoxsie	1	" " " "
Crompton	Henry C. Brown	1	" " " "
East Greenwich	Mrs. L. S. Reynolds	1	" " " "
" "	T. G. Mathewson	1	" " " "
Greenville	Lucius B. Steere	1	" " " "
Kenyon	Geo. W. Chaffee	1	" " " "
Kingston	Stutely Sherman	1	half wild bronze cross gobbler.
Liberty	Allan N. Hoxsie	1	" " " " "
"	" "	2	" " " " hens.
Little Compton	P. W. Almy, Jr.	1	three-eighths wild gobbler.
Narragansett Pier	Browning & Chappell	1	half wild bronze cross gobbler.
" "	W. C. Gardiner	1	three-eighths wild gobbler.
Nasonville	F. E. Bartlett	1	half wild yearling Enty gobbler.
Newport, Fort Adams	E. St. John Greble	1	three-eighths wild gobbler.
Niantic	Chas. F. Eldredge	1	half wild bronze cross gobbler.
Pawtucket	F. E. Sayles	2	three-eighths wild gobblers.
"	Wm. Westcott	2	" " " hens.
Peacedale	R. G. Hazard	1	half wild bronze cross gobbler.
"	Wm. A. Watson	1	" " " " "
Point Judith	J. K. Brown	1	three-eighths wild gobbler.
Portsmouth	W. L. Sisson	1	half wild bronze cross gobbler.
"	" "	2	" " " " hens.
Providence	J. J. Bundy	1	three-eighths wild gobbler.
Rocky Brook	Chas. H. Pope, Jr.	1	half wild bronze cross gobbler.
" "	" "	3	three-eighths wild hens.
Spring Green	Misses E. & H. Francis	1	" " " gobbler.
Tiverton	D. D. Humphrey	1	" " " "
Wakefield	O. W. Nichols	1	" " " "
Warren	M. W. Quann	1	half wild bronze cross gobbler.
Westerly	Courtland P. Chapman	1	" " " " "
"	J. Andrew Chase	1	three-eighths wild gobbler.
West Kingston	Mrs. J. G. Clark	1	" " " "
Wickford	Robert B. Thomas	1	" " " "
Woodville	N. A. Collins	1	" " " "
Wyoming	H. P. Clark	1	" " " "

We have also procured for several of the above parties, fine Rhode Island turkey hens for breeding with these gobblers.

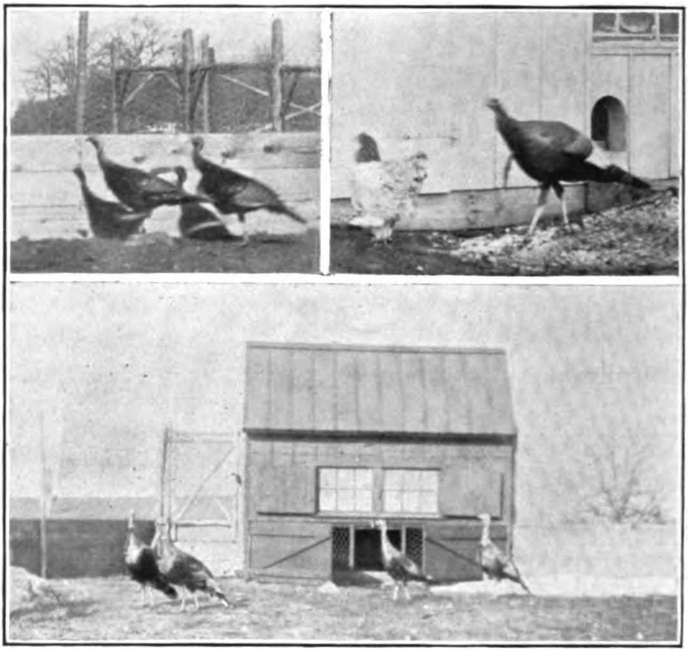
The three-eighths wild gobblers were from Prudence Island, bred from the Enty gobbler, and were sold outright. The half wild gobblers were reared on the Station farm from the Old Maryland wild gobbler, and were sent out on condition that the Station have the privilege of buying them back at the price received for them, after they have been kept one year. As these two strains are unrelated, one having an Enty bird may procure a descendant of the Maryland gobbler from any one that has bred from the half wild or *vice versa*, and thus secure another infusion of hardy, unrelated blood, without getting too much of the wild strain or being put to the expense and uncertainty of sending out of the State.

As farmers may now be able to get the part wild stock of someone in their vicinity, the Poultry Division probably will not again attempt to furnish any number of birds, but will endeavor to see that the supply in this State is kept up, and will assist any one in procuring such birds for breeding.

The coming season a "Laughlin," half wild gobbler now two years old and of entirely different stock from those sent out, will be bred with a few fine, large bronze hens that are two and three years old. Their eggs will not be hatched on the Station farm, but will be sold to Rhode Island farmers. While poultry work may be properly carried on here, it is impossible to keep many turkeys on the Experiment Station farm, as they wander over and interfere with the crops grown for experimental purposes.

This Department could, we think, properly carry on more extensive experiments with turkeys. It might be well to make a careful test of the leading varieties as to hardiness, growth, early maturity and desirable market qualities, compare the various methods of raising and feeding young turkeys and experiment in crossing the various varieties. This would be expensive, would necessitate hiring a large pasture farm for three or more years as well as a man to take charge of the flocks, and without special appropriation in addition to the funds at present available at the Experiment Station, can hardly be undertaken. The results of

HALF WILD. PURE WILD.

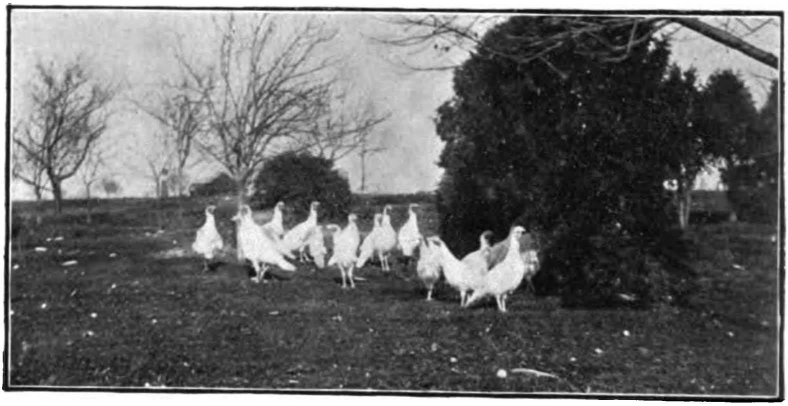


DOMESTIC. HALF WILD.

TURKEY GOBBLERS AT THE EXPERIMENT STATION.

PURE WILD GOBBLER BRED IN CONFINEMENT.

THREE EIGHTHS WILD TURKEYS. PRUDENCE ISLAND.

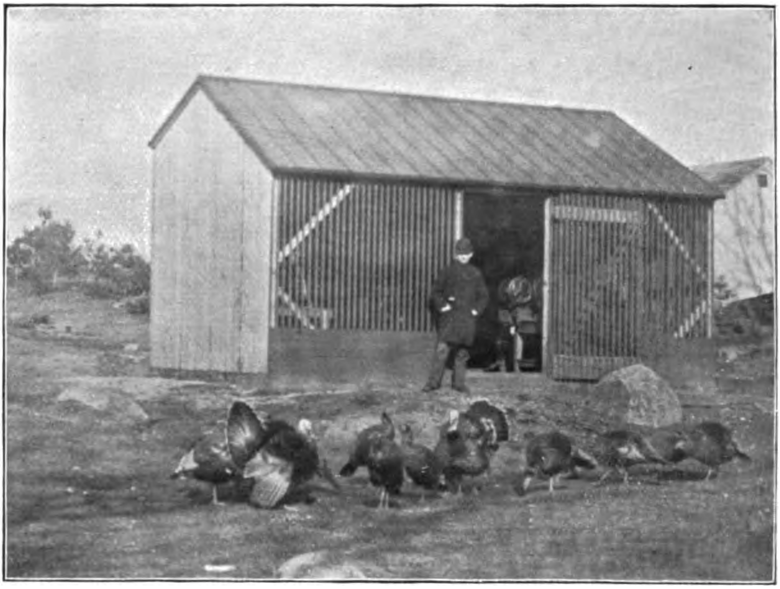


MR. BLOODGOOD'S FLOCK OF WHITE HOLLAND TURKEYS.

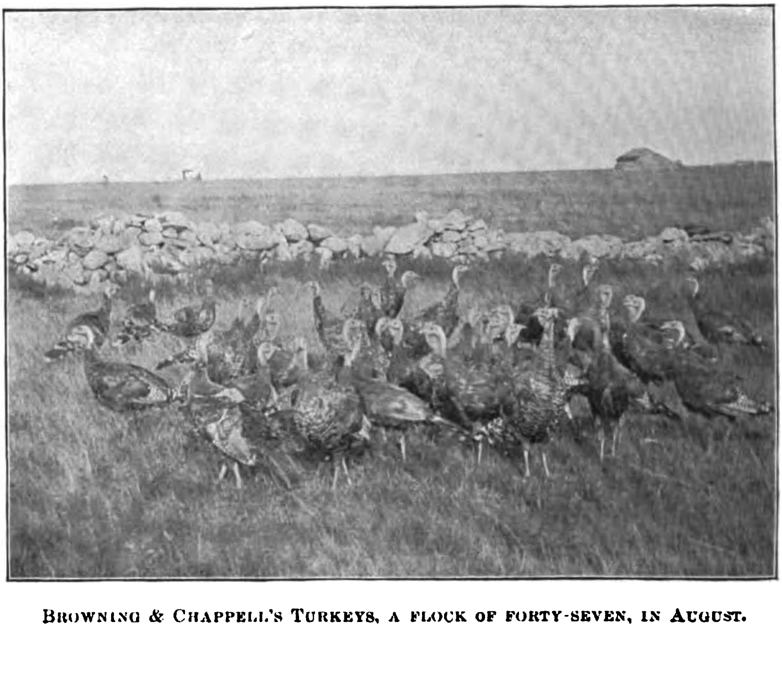
207 Just Before Thanksgiving.

Part of the 207 Just Before Thanksgiving.

Browning & Chappell's Turkeys.



BREEDING TURKEYS.



BROWNING & CHAPPELL'S TURKEYS, A FLOCK OF FORTY-SEVEN, IN AUGUST.

such work, however, if successfully carried out, would be of great value, not only to the State but to the whole country.

CATCHING TURKEYS IN THE FALL.

Beginners, especially, have much difficulty in securing their turkeys when they desire to kill and market them. A bungling and unsuccessful attempt to catch a flock may make them so suspicious that they cannot be surrounded or approached the remainder of the season. Repeated attempts to catch them increases their wildness, and frequently the only way to secure them has been to shoot them. This is more apt to be the case if the stock contains wild blood. Old hands at the business have learned by experience the proper course to pursue. The usual plan is to get the birds into a barn or carriage shed and shut them in. In order to do this they are fed for a long time in front of or just within the place in which they are to be caught. Later, the feed is placed within the building and they become so familiar with it that they are unsuspicious when within. The feeder takes pains not to appear to notice or watch them and moves about very slowly and quietly. When they are to be caught the doors of the building are suddenly closed or a covered yard of wire netting is built in front of the building and closed when all are in. Usually when they find they are confined they become frightened and fly back and forth or huddle up in corners, and sometimes many are smothered beneath the pile of frightened birds. In flying back and forth against the netting, their wings become bruised and their appearance when dressed is injured. To overcome this drawback, certain raisers have improved the usual make-shift catching place by building a long, low, dark pen, back of the barn or shed. This pen extends alongside of the building, and is at right angles with the entrance to it, and at the extreme end is about two feet high. Up to the time of their being caught the end is left open and the birds frequently find their way through it. When closely approached from the front when feeding in the

building, they rely upon this means of escape and are not frightened. When they are to be caught, only what the pen will comfortably take, are driven in. They do not discover that the end is closed until it is too late to try to turn back. The turkeys that are not to be caught are first driven away, otherwise they may be alarmed and become unmanageable. No turkey that is thus caught and has learned the mysteries of the trap is ever allowed to escape or its suspicions would be communicated to the others. When shut in this pen they are quiet, and when a man goes to catch them there is no struggle, he simply reaches out and takes them by the legs. The pen is too dark and narrow for them to fly and too low for them to crowd one upon another.

A STUDY OF THE DISEASES OF TURKEYS.

The bodies of most of the young turkeys that died on the Experiment Station farm were secured and examined, and in almost every instance their livers were found to be diseased and spotted. Of the few which died when nearly mature, part had badly diseased livers, while the remainder seemed to have had simple acute diarrhœa. Of those sent to us from other parts of the State that had died of "Black Head" at maturity or when being fattened, the livers were one mass of hardened, yellow lumps. Whether this trouble originates in a digestive derangement which gradually causes morbid changes in the liver, or is directly due to infection, we cannot say. Sections of these livers preserved in alcohol have been sent to Dr. Theobald Smith, Chief of the Division of Animal Pathology, Bureau of Animal Industry of the U. S. Department of Agriculture at Washington, who thinks the specimens indicate that there is an infectious disease to be dealt with, but cannot fully determine without fresh material, which we have not, up to this date, been able to secure.

A knowledge of the cause of a disease is a great help in showing how it should be dealt with, but much may be done before we get that knowledge.

Although the greatest trouble in raising turkeys may be due to a lack of vigor or hardiness,—the result of breeding from young, inferior or closely related stock,—there is no question but that turkeys, as well as other living creatures, are liable to be destroyed by diseases which even the most vigorous may not escape if exposed to the most virulent form. Over-feeding, under-feeding, lack of exercise and various influences may make individuals more susceptible, but certain infections are so powerful as to overcome even the strongest and finest specimens. If Black Head is a disease, even though the cause is yet unknown, certain general principles may be followed in preventing or stamping it out.

Cholera, scarlet fever, diphtheria, and many other serious diseases which afflict man are all prevented from becoming general by nearly the same means. These diseases are propagated by germs given off by the patient. If infected persons are not immediately separated from the well, and isolated,—prevented from coming in contact with others,—they would cause an epidemic, which once well started, might sweep the country. Not only are such patients kept in quarantine, but those who care for them are also prevented from coming in direct contact with the well. When the disease has run its course, the patient, the attendants, the rooms occupied, and every article that the germs may have come in contact with are disinfected,—cleansed with some solution that kills germs. If this is properly done all of the germs within doors are destroyed. If this were not done every one using the same rooms, clothing or articles in the room would be liable to infection, even a long time after the patient had vacated the premises. Germs of disease may dry up, and, if not destroyed, again become active a long time after, if given suitable soil to grow in. They grow faster and multiply with greater rapidity in some soils, and, as in the case of weeds grown in sand and rich loam, the ranker the growth, the more rapidly they spread, the greater the number of germs thrown off and the greater their power. Living surfaces having healthy secretions are poor soils for germs, while

abnormal secretions may enable them to thrive. Filth and decaying matter nourish certain germs. Healthy organs resist and may destroy a certain quantity of disease germs, but may be overcome by a much greater number.

A fowl having a simple cold may in a locality where there has been no roup have simple catarrh a long time and then get well without having anything else, while the same fowl in quarters where many fowls have had the virulent roup will, unless washed with a disinfectant, get the offensive symptoms in a short time.

Immediate isolation and disinfection should be as promptly enforced in the case of diseased fowls as with diseased persons. If Black Head is contagious, as supposed, it could have been prevented from becoming so general if vigorously attended to when it first appeared, and may now be stamped out in this State by means similar to those used by any Board of Health. Every infected flock is a menace to other flocks. Kill and burn, or bury deep all diseased birds, disinfect that which they have contaminated, if possible, and remove the survivors to fresh, uncontaminated land, and keep this up. Other turkeys should be prevented from going on to the infected land. This, in combination with the use of vigorous stock only, bred and fed and cared for according to the best methods, should do away with the mortality among turkeys.

TAPE WORMS IN TURKEYS.

Last September when visiting a turkey raiser in this State who was occasionally losing turkeys, we secured of him a bird that had just died, apparently of bowel trouble, and took it home for dissection. A thorough examination was made to find the cause of death. Upon opening the abdominal cavity nothing out of the way was seen, the liver and other organs being apparently in a normal condition. When the alimentary canal was laid open its entire length, it was found to contain a large number of very slender tape worms, in all stages of growth, from a quarter of an inch long to 18 inches or more in length. In some parts of the

bowel they were extended their entire length, and in others large numbers were bunched or knotted together almost plugging the opening. As many as forty were secured and when dropped in alcohol were quite lively for a time. Since this we have endeavored to secure other birds similarly affected, but owing to the lateness of the season none have been found. In response to our inquiries, a number of turkey raisers inform us that they have known whole flocks of turkeys to have tape worms, and some admit having paid little attention to the matter, believing that they did turkeys no harm. Others realized that turkeys, as well as calves or hogs, do not thrive if so affected. A few believe they cause the death of many young turkeys. They appear to be most troublesome in early spring and in July. One close observer informs me that they have seen little short worms a quarter of an inch long on the grass in early spring time, which the turkeys pick up. They have seen young turkeys, three weeks old, that had tape worms a foot long. Their young turkeys had this trouble in July and August, and more in the latter month. Birds affected thus, frequently have spasms and are much affected in health and may die. After three months old they do not seem to be so unfavorably affected. At certain seasons, segments of worms may be found early in the morning under the roosts among the droppings of infected turkeys. The warm months seem to be the time when they are most plenty and active. They are not noticed in the fall or winter.

THE NATURE OF TAPE WORMS.

Tape worms are defined as flat worms without a mouth or alimentary canal, having a head and many segments. Their nourishment, the digested contents of the intestines of their host, is received by absorption. The head or nurse is provided with suckers and some groups with curved, claw-like hooks by which it fastens itself to the intestinal membrane. Different species vary in length and number of segments. New segments or joints are gradually formed next to the head, and the individual joints

increase in size and maturity as their position, on account of the formation of new segments, grows farther from the head. Each segment contains complete male and female organs. The adult worm is in fact a ribbon-like colony of constantly maturing hermaphrodite bodies, which separate from the parent and pass off. These ripe segments contain a large number of embryo tape worms. The embryos may be conveyed to the host in several ways. Some require an intermediate host for a certain stage of their development, others do not. They may be taken into the alimentary canal along with the food or water, and infection may take place by means of the free eggs or by the whole segment containing the eggs.

The embryos of certain species that pass their first stage in an intermediate host, after being released from the egg by the digestive fluids of their first host, spend a certain time in the stomach or intestines, and then perforate its walls and reach other parts or organs which they burrow into, where they further develop and become encysted. On account of the sac or membrane which surrounds them at this period, they are known as bladder worms. These cysts remain inactive until taken up and swallowed by another host; then the embryos are released by the digestion of their envelopes, and they attach themselves to the walls of the intestines, form segments and develop into adult tape worms. At the stage when they burrow into the vital organs of their intermediate host, they may cause injury to these organs or cause the death of the animal by the puncturing of a blood vessel. The liver is most liable to be infested with bladder worms.

Other species of tape worms, it is said, have no intermediate host, and do not become encysted at any stage, but commence to develop into adult tape worms as soon as the embryos reach the intestine.

Something may be learned about the effect of tape worms on sheep by a study of "Animal Parasites of Sheep," published by the Bureau of Animal Industry, U. S. Department of Agriculture, and from which we glean the following:

Bladder worms that have become encysted in an animal, the intermediate host, are taken into the alimentary canal of some carnivorous animal, which devours the infested entrails. Having gotten into the intestines, the worms then develop into adult tape worms. Each adult segment contains a complete hermaphroditic germinative apparatus. They mature toward the last segment. The terminal segments when ripe, separate and pass away. In this way, segments which were near the head gradually become central and finally terminal, growing adult, maturing their embryos, and passing away in time. These eggs in some way, probably by adhering to food or floating in drinking water, find their way into sheep, and eventually the worms tunnel their vital organs, most frequently the liver. Young sheep and lambs are most affected, and frequently die from hemorrhage.

Collies, or shepherd dogs, hounds and slaughter house dogs are most liable to be infected with adult tape worms of this kind. Wandering dogs that harbor them scatter their eggs far and wide and at drinking places. They are a constant menace to the lives of the flocks in their vicinity. Foxes or wolves that devour the entrails of infested sheep may become causes of infection. Rabbits, skunks and woodchucks have been suspected of harboring these parasites. As dogs become infested by eating the viscera of dead sheep, all entrails should be buried, burned or rendered.

There are so many diseases that may be spread by the entrails of animals and fowls, that they should always be long and thoroughly cooked before they are fed to any living thing.

Every sheep owner should periodically dose his dogs with worm medicine whether they are known to have tape worms or not. Areca nut, followed by a dose of castor oil, is found to be the best worm medicine for dogs. In the work mentioned, Cooper Curtis, D. V. S., M. D., gives his investigation regarding two species of tape worms infesting sheep, that have a different life history from the bladder worm, the fimbriate tape worm and the broad tape worm.

The fimbriate tape worm persists in the adult stage in older

sheep throughout the year. The smaller forms appear in lambs soon after the second month of their age, and may be found in sheep of any age, excepting possibly during the winter months. They require at least six months to attain adult size. The ova or embryos are continually passed from the sheep to the ground throughout the year. The life of the embryo from the time it leaves one sheep until found in another, is yet undiscovered. When present in considerable numbers in sheep, it determines a disease which is not only detrimental to the value of the animal, but at times causes the death of large numbers. No medicinal remedies can be recommended which will assuredly remove fimbriate tape worms from sheep. Many measures may be taken which may prove to be effective in two ways; first, in preventing sheep from becoming infected; second, in enabling the sheep to better withstand the ravages of the parasite, and thus carry it over the critical stage of its existence. The lambs and yearlings are the greatest sufferers, and it is to these that the most attention must be paid. These tape worms are found in the duodenum and gall ducts of sheep. Some times as many as from thirty to one hundred specimens are found in the duodenum, more often there are from two to thirty. Nearly every sheep in a flock will be infected. This worm causes by far the greatest loss of any intestinal parasite in this country. It is said to be common throughout the West. The worms found in the duodenum are smaller than those found in the gall ducts. In a lamb two months old, a worm half an inch long has been found. Four or five months afterward they will be found four and five inches in length. No mature or adult worms capable of furnishing embryos for the infection of adult animals are found in lambs less than ten months old.

EFFECT ON THE HEALTH OF LAMBS.

Lambs that should be fat and strong, are not, and die during cold weather. The parasites hatch and grow slowly, and become quite plenty before much disturbance is noticed. In the fall, the

symptoms increase. The worms irritate the intestines and finally induce catarrhal inflammation of the duodenum and billiary duct, the liver also becomes affected from its ducts being plugged. Mature sheep do not die from this tape worm alone. The greatest losses are among the lambs and yearlings. Tape worms render them more liable to other affections and less able to withstand the inclement season. Tape worms are responsible for more losses than any other sheep disease on the Western Prairies, excepting scab. For prevention, it is advised that young lambs should be driven to new, uncontaminated pastures about the time that they commence to eat grass and drink water, and after being weaned, again changed to fresh pastures and kept there until winter and then kept on uncontaminated ground until two years old. Eighty to ninety-five per cent. of the sheep in some parts of the West are infected. A sheep may have a few parasites and not be seriously affected by them.

BROAD TAPE WORM OF SHEEP.

This is the best known parasite of sheep, because of its flatness, length and large size. In the summer and fall it is quite abundant. It is common in every sheep-growing section of the United States. It causes periodical epizootic outbreaks. Its spread is due to over-crowded pastures. It requires no intermediate host, and its growth is very rapid. Worms two to five yards long are found in lambs from two to four months old. Its growth is a yard a month, hence the trouble rapidly develops in young lambs. Its growth is so much more rapid than that of the fimbriate tape worm that the disease culminates in younger lambs. With this species the embryos pass from sheep to sheep and develop into adults which reproduce young for the infection of other sheep. Sheep often harbor tape worms and give no evidence of their presence until after slaughter. It is unusual to find more than a half dozen adult worms together in one animal, but there may be a hundred. Fourteen adults have been found in a lamb four

months old. The worms irritate the bowels and cause excessive secretion of the intestinal fluids. The animals walk with a tottering gait and often drink more and eat more and die of diarrhœa and sheer exhaustion. In Colorado outbreaks occur annually about July and August. They are more prevalent in the summer season. While the fimbriate tape worm does not yield to medical treatment, the broad tape worm does, as the latter is never found in the gall or pancreatic ducts, but lower down in the bowel where it can be dislodged. Various remedies are used for removing broad tape worms, and some are recommended as having given good results. Koussin, also known as taeniin or brayerin, gives the best results; 2 gramme doses being given have expelled the tape worms, while the animals remained cheerful, retained their appetites, and improved in condition. Powdered male fern, 2 ounce doses, is recommended, or the aetheric oil of male fern in dram doses. The latter is best. It can be given in combination with from 2 to 4 ounces of castor oil. Tansy is also used, the dose being 2 to 6 drams. It is much used as a preventive of worms. Ground pumpkin seed is also used as a remedy. Powdered areca nut is much used and is followed by a purge. It is also used in combination with oil of male fern. When sheep are infested by tape worms, a large part or all of the flock are affected, and the symptoms shown by different individuals are similar. Adult tape worms seem to irritate the intestines, derange their functions and cause nervous disturbances. Sheep owners are advised to diagnose the disease, find out what the trouble is, in its earliest stages, by sacrificing one or more of the worst affected, and thus gain time in treating and preventing the extension of the disease. It is in the beginning of the disease that treatment, both hygienic and medical is needed, and produces its best results.

The foregoing in regard to tape worms of sheep, gives us a clue as to what may be expected as the result of the same in turkeys, and also indicates what may be done to prevent them. The worms found by us in the young turkey mentioned were, except in being very small in size, almost identical in appearance to rep-

resentations of the broad tape worm. Segments, general proportions and shape of head were apparently about the same, and we may be allowed, perhaps, until more is known of its history, to look upon it as having similar habits. Specimens have been sent to Bureau of Animal Industry, U. S. Agricultural Department at Washington, but they arrived in too poor condition to be identified. No others have since been secured owing to the lateness of the season.

We present the foregoing that the farmers of the State may have their attention called to this affection, and may save time in detecting and taking preventive measures against it. Also that we may secure their immediate coöperation in securing infected birds the coming summer.

As the gape disease of fowls and turkeys causes much loss in various parts of the State, and there are a great many people within its boundaries who do not understand the cause of the trouble or know how to cope with it, the following, compiled and condensed from the best sources, will be of value.

GAPE WORMS OF POULTRY. (*Syngamus Trachealis.*)

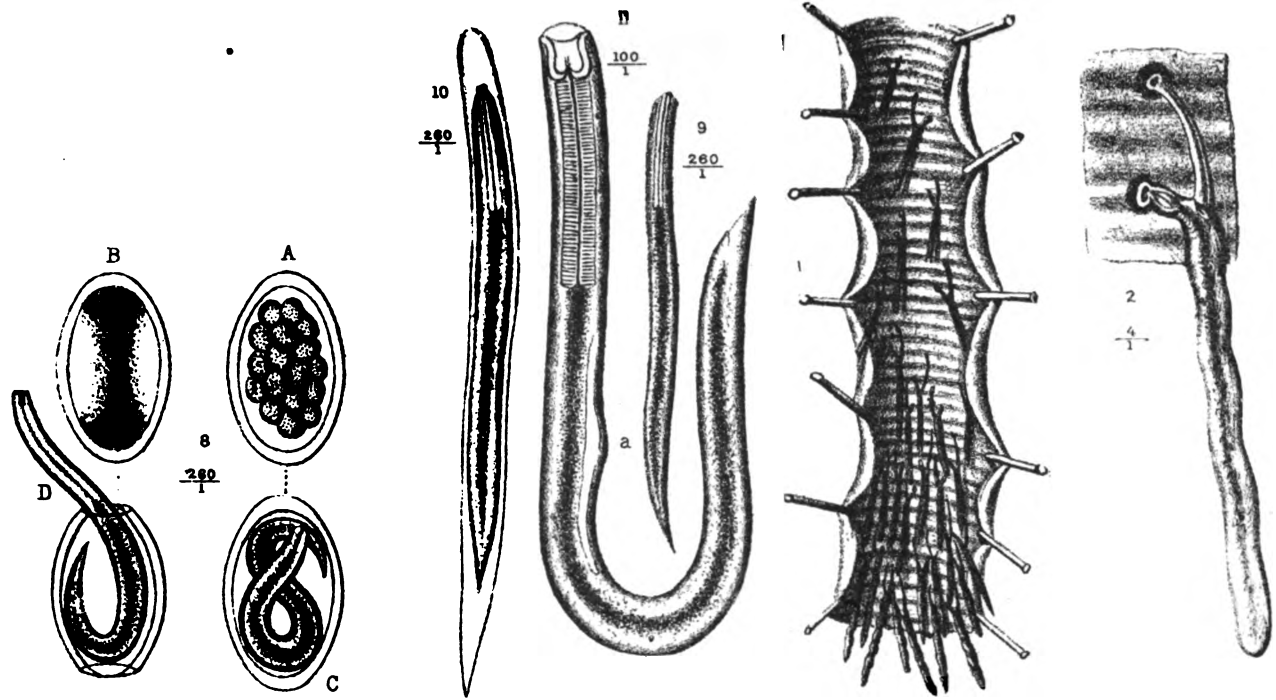
Nearly one hundred years ago (in the Medical and Physical Journal, published 1799, article dated May 21st, 1797), Dr. Wiesenthal of Baltimore wrote, "There is a disease prevalent among the gallinaceous poultry in this country, called the gapes, which destroys eight-tenths of our fowls in many parts, and takes place in the greatest degree among young turkeys and chickens bred upon old established farms. Chicks and poults, in a few days after they are hatched, are found to open their mouths wide and gasp for breath, at the same time frequently sneezing and attempting to swallow. At first the affection is slight, but it gradually becomes more and more oppressive, and it ultimately destroys. Very few recover. They languish, grow dispirited, droop and die. It is generally known that these symptoms are occasioned by worms in the trachea. I have seen the whole windpipe completely filled

with these worms and have been astonished at the animals being capable of respiration under such circumstances."

In 1872, Dr. Crisp of England estimated that this red worm annually destroyed half a million chickens, besides pheasants and partridges, and he felt that it was of national importance that a means of preventing its invasion or destroying it be found. While this disease had long been known in this country and England, it appears not to have become common or very destructive in France until quite recently. Its ravages among the pheasantries of the hunting forests of France, caused M. P. Megnin, a French scientist, to investigate this disease in that country in 1878 and 1879. Profiting by the work that had been previously done by Siebold, Dujardin, Nathusins, Cobbold and others, M. Megnin was enabled to add much to the knowledge of the reproduction and development or life history of the gape worm, which indicates the best means by which to combat gapes successfully and arrest its spread. In 1880, M. Megnin published a memoir on this subject and was awarded the prize of fifty pounds offered by the London Entomological Society, October 1st, 1879, for the best and most complete life history of the worm supposed to produce the so-called gapes in poultry, game and other birds. From a translation of this paper, published in the Report of the Bureau of Animal Industry, U. S. Agricultural Department, 1884, we condense the following: This worm is terribly destructive to both wild and domestic birds. Fowls, turkeys, geese, partridges, pheasants, storks, magpies, robins and green wood-peckers are subject to infection. It is most prevalent in July and August. The chief symptoms are a suppressed cough and a peculiar gasping, from which the malady is named. This disease is particularly destructive to the young, when from six weeks to three months of age. As many as twenty of these worms, averaging $\frac{5}{8}$ of an inch in length, have been found attached to the mucous membrane of the trachea, which together with the lungs was in an inflamed condition. This so-called forked worm in reality consists of a male and female permanently united. The female

VARIOUS STAGES OF THE GAPE WORM OF FOWLS.

(Reproduced from Report of Bureau of Animal Industry U. S. Agricultural Department.)



8. Ova in different stages of Development. C. shows ova with valves at extremities detached and embryos emerging. (Enlarged 260 times.)

9. Embryo directly after leaving the egg.

10. Embryo somewhat older and undergoing first moult. (Enlarged 260 times.)

11. Nymph. (Enlarged 100 times.)

1. Treachea of adult pheasant slit open longitudinally, showing thirty pairs of gape worms in various stages of development. (Natural size.)

2. A pair of gape worms. Mouth of male and female attached to treachea. (Enlarged 4 times.)

is fixed to the tracheal mucous membrane of its host; the male is likewise attached by its mouth to the same mucous membrane, and permanently coupled, immovably attached, to the female. Their food is the blood of their host, which also gives them their red appearance. The eggs are developed within the female and emerge only after her death. The eel-like embryos never leave the eggs while they are within the living body of the mother, however complete the development of both may be. Only by the death of the female and the destruction of its body are the ova placed at liberty. The embryo will then emerge from the egg if the surrounding medium offers favorable conditions. These are moisture and a temperature of at least 68° F. In a moist state, the eggs preserve their vitality for months, or even a year, if the temperature is kept below 59° F, but under these conditions the contents of the eggs eventually become dissolved. If placed in a dry medium, like dry sand, their contents dry up the more rapidly in proportion to the elevation of the temperature. If an unimpaired egg is kept moist and subjected to a temperature of 77°, the embryo within the egg moves and turns about and finally escapes by pushing away one of the coverlets. Twenty-eight to thirty days of such a degree of warmth, with moisture, is sufficient for the development of the embryo and its escape from the shell. These embryos live in water where they swim about in a serpentine manner. They have been kept alive at this stage almost a year by subjecting them to a low temperature, but with a temperature of from 68° to 77° they did not live more than eight or ten days. The illustrations, reproduced from report of U. S. Bureau of Animal Industry, 1884, represent the various stages from the egg to the mature worm attached to the trachea. Fowls or birds become infected in several ways. Young pheasants affected with this malady frequently expel, in a fit of coughing, plump, fat gape worms full of eggs. Other fowls near by consume with avidity the worms thus ejected. Two or three weeks later these same young fowls are sure to present symptoms of the malady.

A parrot, fed four large gape worms by M. Megnin on the 7th

of August, began to cough and gape on August 28th, and on September 10th it died, suffocated by the gape worms which were found crowded in the trachea. The mature female gape worm contains several thousand eggs. About thirty or more pairs of worms are usually found in the trachea of one fowl. M. Megnin found the nymphal form of the worm in the air sacs and bronchi of young partridges, therefore he considers the knowledge of the different stages of the gape worm to be complete. He believes that the only two media inhabited by this parasite during its entire existence, are the water and moist earth during its embryonal condition and the respiratory organs of its victim during its nymphal and adult stages. As the vitality of gape worm eggs may be preserved a long time, food and water containing either eggs or the live embryos are probably the two most common means of infection.

M. Megnin gives various remedies that are recommended. The disease was overcome and prevented by not only relieving the affected fowls of the worms, but by removing them from infected locations, by taking great care of the drinking vessels, frequently renewing the supply with very pure water, and by adding a good dose of garlic to their feed. Where the garlic was faithfully used the gapes was arrested and completely driven out. Assafœtida, a strong smelling vermifuge, was also used with success in place of garlic. Salicylic acid was also added to the drinking water, 15½ grains dissolved in 3½ fluid ounces of distilled water being added to each quart of drinking water. For destroying the infection in the soil, water containing a large quantity of salicylic acid or sulphuric acid is recommended.

Since the report mentioned was published, investigations were carried on in 1883 and 1884 by Dr. H. D. Walker, of New York State, which led him to believe that earth worms act the part of host to the gape worm embryos, and that they are the principal means of spreading the gapes. He was employed in 1885 for several months by the Bureau of Animal Industry to repeat these experiments, and to furnish the Bureau with material for carrying

on similar experiments. As the result, earth worms from infected ground were found to infect both fowls and robins that were fed with them, while earth worms from non-infected ground caused no such trouble. Water containing embryos just hatched was poured down the throat of a chick, and eight days after twenty-nine pairs of gape worms were found in its trachea. The same portion was given a robin and symptoms of gapes were noticed in eight days, and when it was killed on the fifteenth day, three pairs of worms were found in its trachea. At the laboratory of the Bureau of Animal Industry in August, 1884, the eggs were found to develop and hatch in thirteen days with the temperature ranging from 76° to 88° F. Dr. Salmon, Chief of the Division, says (Report of Animal Industry, 1885, page 277) "the foregoing experiments show that earth worms of infected places do contain the embryo," also "that the earth worm is not a necessary host." "To Dr. Walker, however, belongs the credit of having pointed out the interesting fact that earth worms of infected grounds may produce the disease in chicks which feed upon them."

Dr. Walker in an article published in Bulletin of the Buffalo Society of Natural Sciences, No. 2, Vol. 5, and in articles written for the Fancier's Journal, April 9th and May 21st, 1892, takes the ground that if chickens are kept from eating earth worms, which contain the embryos of the gape worm, they will not have the gapes. He has found the live embryos of the gape worm in earth worms at all seasons of the year. He has found twenty in a single earth worm, and he believes that earth worms are a necessary intermediate host for the preservation of the species from one season to another. He argues that without the aid of earth worms the gape worm would be exterminated in the Northern States, where the soil is often frozen to a great depth. Within its host, the earth worm, the embryo is protected and carried deep into the ground out of the reach of the cold during the winter and brought up again to the surface in the spring ready to be picked up by its final host, the fowl. He has dug out earth worms in an infested locality from deep down in the ground in midwinter and found

them to contain the gape worm embryos. He believes that the reason chicks do not contract the disease by swallowing the unhatched eggs, which have retained their vitality though exposed a long time, is that the digestion of a chicken is so rapid that the eggs pass off before they have time to hatch. He asks: "*How do young chicks* in the early spring first get these parasites?" "Certainly not in this way (drinking water containing the germs), in our climate for the water and embryos would have frozen a hundred times during winter and spring." I will concede, says Dr. Walker, that if they should take in the live embryos from the ground in drinking water, they would have the gapes, so, also, if man should drink the embryonic trichinæ in water, instead of eating them in pork, he would have the greatly to be dreaded trichinosis. But the question is not what might happen, what does actually take place in nature. Besides this you have the fact, as before stated, they cannot endure the cold of winter on the surface of the ground. Dr. Walker's claim is that the earth worm is necessary as a bearer, preserver and distributor, but not as a host in which any part of the development takes place. Eggs were not found in earth worms but embryos were. Chickens fed with just hatched embryos or those found in earth worms, developed the gapes in about seven days. In fourteen days the worms contained fully developed eggs. The greater part of the maturing worms may be coughed up and swallowed before they secure a hold. He found large numbers of perfect eggs in the droppings of infested chickens. Chicks fed fresh eggs do not have gapes, as the eggs pass through before they have time to hatch. Eggs scattered on the ground hatch much quicker in the hot months of summer than later in the season.

Eggs probably perish in cold weather. He found evidences that the embryos reach the lungs by penetrating the æsophagus. The lungs of infested chickens are usually found to be somewhat diseased, evidently the result of the irritation caused by the development of the worms in the lungs. Older chickens are not so susceptible, they have more power to dislodge the worms from

the trachea and are not embarrassed by a few. For a prevention, he says, you can either keep your chickens on a floor or on ground over which infested chickens or birds have never run, or if this is not convenient, kill the earth worms in the soil, by saturating it with a solution of common salt, one or two pounds to a gallon of water.

Newmann says the ova are developed to a varying degree in the female, according to its age and size, and therefore some hatch sooner than others. They have been found to hatch in from seven to forty days after the death of the female, according to the temperature and previous stage of development.

Mr. Dalziel claims that pheasants and fowls have gapes when kept in regions where earth worms are not natural to the soil, where there are in fact no earth worms.

A very interesting discusssion of this subject, by Dr. Roth, Dr. Walker, and Mr. Valentine of this country, and Mr. Dalziel of England, will be found in the Fanciers Journal of 1892.

WELL TRIED METHODS OF CURE.

There are many very old and effective remedies for removing gape worms. Air-slacked lime has long been used and has been found to promptly remove the worms from the trachea. Afflicted chickens are placed in a box which is covered with a sheet of thin muslin. On this muslin is placed a handful of air-slacked lime, the muslin is then jarred to cause the dust of the lime to fall through, which enters the lungs of the chickens and causes them to cough off the worms. The lime is supposed to affect the worms which release their hold or do not retain so strong a hold on the wind pipe. This is said to do no harm to the chick and to be a sure cure.

Another old fashioned method of treatment which seems to have been quite generally followed with great success, is to confine the chickens to a canvas covered box while they are fumigated with the fumes of carbolic acid. The fumes are produced by pouring a teaspoonful of carbolic acid on a red hot brick placed in the corner of the box. If there is glass in one end of

the box, the chickens will huddle against it and keep away from the corner where the brick is, while their actions may be watched through the glass. If the fumes seem too dense, ventilation may be given. A minute is usually long enough to expose them to the fumes. By the use of a sliding door in the box, the chickens may be driven into the box from their coop in any number desired. An upper compartment for the chickens, having a slat floor, under which the acid is burned, would be most satisfactory where a large number are to be handled. Dr. Roth, Mrs. Carson and many others have long followed this plan of treatment with great success. The only objection to it is that if the chickens are fumigated too long, they may be killed as well as the worms. This treatment is also valuable for the cure of roup. Mrs. Carson, who gives her experience with gapes in the Poultry Keeper, says: "Doubtless turpentine or assafœtida, persistently used, will prove beneficial and prevent its spread, but nothing is so prompt and effective in destroying the worms in the windpipe as carbolic acid fumes." She has found that her chickens which have been fed freely with onion tops, have been free of the disease.

Wherever gape infested chickens have been long kept, the ground becomes infected with the germs and remains infected just as long as chickens are kept there. Curing the chickens will not remove the infection. If none are kept for a sufficient length of time, it dies out for want of necessary conditions for development. It is folly to put young chicks on a plat of ground infected with gape worms unless we can free it from contamination. Mr. Kulp, who lives in Pennsylvania where every old farm is infected and where many thousands of chicks are annually destroyed by gapes, tells the readers of Farm Poultry how he clears the ground of the taint. He makes a pen containing 100 square feet of ground for each fifty chicks, and in each pen he spreads a half bushel of fresh air-slacked lime; this will free the ground in the pen. The chickens, after being kept in the pen for eight or nine weeks, are allowed to run free. After that time not one has the gapes unless there are a few stunted, unthrifty chicks. The

same quantity of coarse salt may be used in place of the lime, but it must be dissolved by water or rain before the chickens are put in or they may eat it and die. To remove the worms from a chicken, he drops six drops of strong salt and water down the windpipe, with a feather. He has tried all the other remedies he has read of and likes this best, as it will quickly and surely cure them, and is simple and not as severe as most of the others. Camphor and water, camphorated sweet oil and crude petroleum are each recommended, one drop in the windpipe from a medicine-dropper, oil-can or feather, is said to be all that is necessary to kill and cause the removal of the worms. A feather stripped of its web, except at the tip, and moistened with a mixture of sweet oil and turpentine, is used by some. It is inserted in the windpipe and twisted as it is withdrawn. Worms may be destroyed in this way but it is not practicable where large numbers of chickens are to be treated. Some poultry keepers simply apply turpentine externally to the mouths or throats of the chickens having gapes. Fine tobacco, petroleum, turpentine, assafœtida and alum, all have been recommended for mixing with the feed, to prevent and stamp out the gape disease.

M. Megnin gives each pheasant 7½ grains of assafœtida combined with same quantity pulverized yellow gentian in their feed. Five to ten drops of turpentine to a pint of meal made into dough is used by some. The turpentine, garlic or assafœtida is absorbed into the system, and as it is volatile, it is thrown off through the lungs and brought into contact with the parasitic worms in the windpipe, to which it is fatal, and they are ejected with the mucous.

The importance of the total destruction of the parasite after their removal, should be realized. If the worms are killed and thrown upon the ground, it is scarcely likely that the mature eggs will have sustained any injury. Decomposition will set free the eggs, the young embryos escape and enter the soil, and ultimately may find their way into the air passages of some bird. The worms, as well as the dead bodies of anything affected with them,

should be burned if we wish to prevent the spread of the disease. If infected birds are buried, earth worms or skunks may bring the infection to the surface.

Pools and wet places are supposed to be favorable to the preservation and development of these germs. It has often been observed that gapes are more prevalent during a wet spring and during those summers following a mild winter. In stamping out this trouble, the importance of the addition of a small quantity of some germicide like carbolic acid, salicylic acid, assafœtida or petroleum to the drinking water, sufficient to destroy worms or eggs that are ejected therein, should not be overlooked.

STATE CONTROL OF CONTAGIOUS DISEASES AMONG POULTRY.

Contagious diseases are the greatest drawback to successful poultry raising. The energetic and intelligent poultry keeper takes precautions and carries out sanitary measures which usually practically keep his stock free from disease of this nature, but the majority do not appreciate the great need of such precautions, and many that do, fail to act with sufficient promptness, to overcome disease at the start. No matter how careful a poultry man is in such matters, if his neighbor, whose land adjoins his, neglects disease among his fowls or turkeys, his own receive the contamination. Wise poultry men avoid this danger by securing a location that is remote from the premises of neighbors, but whatever the precaution taken by careful men their stock is in danger if infection makes progress in any part of the State. It may be brought to his flock in many ways. One who cares for infected stock may bring infection in his clothes. Articles from contaminated farms may infect a farm that is free from it. Every diseased flock is directly or indirectly a menace to the health of all others, unless special precautions are taken with them. They are for the time being, propagators of disease germs which are constantly being given off. These are scattered about and the surroundings become a future source of infection. To prevent this, the State has the right to interfere. State governments protect their in-

dustries from injury. The production of poultry and eggs is a great industry in this State. Hundreds depend upon it as their principal means of support, while thousands receive income from poultry. There is no State in which poultry production is so general or carried on, on a more extensive scale. No State has a better market for poultry products. Geese from Rhode Island lead in the New York City markets. Rhode Island turkeys are celebrated the country over as being the best that are produced, but their production has been on the decline for many years on account, it is supposed, of a contagious disease that is prevalent among them.

The prosperity of the poultry industry depends upon the health of the stock more than upon any other thing. Measures that will make disease less prevalent will benefit all who keep poultry. Is it not then the duty of the State to adopt and enforce some such measures? It should be against the law for one to harbor on his premises a disease which threatens the ruin of other flocks. If all owners were compelled by law to report to State authorities, all cases of suspected contagious diseases in fowls, an investigation promptly made by a qualified person, would determine whether or not there was present a serious trouble, and if so, prompt and effective measures could be taken that would stamp out the disease in that quarter and prevent its spreading farther.

Thorough disinfection of contaminated surroundings is of as great importance as the proper disposal of the bodies of diseased individuals. This should be done at State expense by competent and careful officials. Where the area is so great that it cannot be properly disinfected, the keeping of poultry on the land should be prohibited for a time long enough to allow the infection to die out.

While measures for preventing and stamping out diseases among poultry are not so urgently needed as for the prevention and extermination of tuberculosis among cattle, which so dangerously affects public health, yet the need exists, and the matter should be properly presented to the public. Diseases destructive

to live stock interests and to which human beings are not liable, have been thought worthy of special legislation in many states.

Texas cattle fever, pleuro pneumonia, the scab disease of sheep and other infectious diseases have been placed under Government control to protect stock owners. Are not raisers of turkeys and poultry equally entitled to protection? They are equally liable to loss in this way. We believe that the time is not far distant, when a very rigid live stock inspection will be carried out in each State, and that it will be considered just as necessary to inspect poultry. Although this work of investigating serious diseases of poultry is the legitimate work of a State Live Stock Commission, rather than that of an Experiment Station worker, until some provision is made for such inspection, the head of the Poultry Division may be able to investigate some of the most pronounced cases, and would like to be informed of all serious outbreaks of disease among poultry of any kind, that may occur in any part of the State. Such information will at least furnish data as to the necessity of adequate measures for the control of poultry diseases and may be of use in the framing of suitable laws.

PRECAUTIONS AGAINST DISEASE.

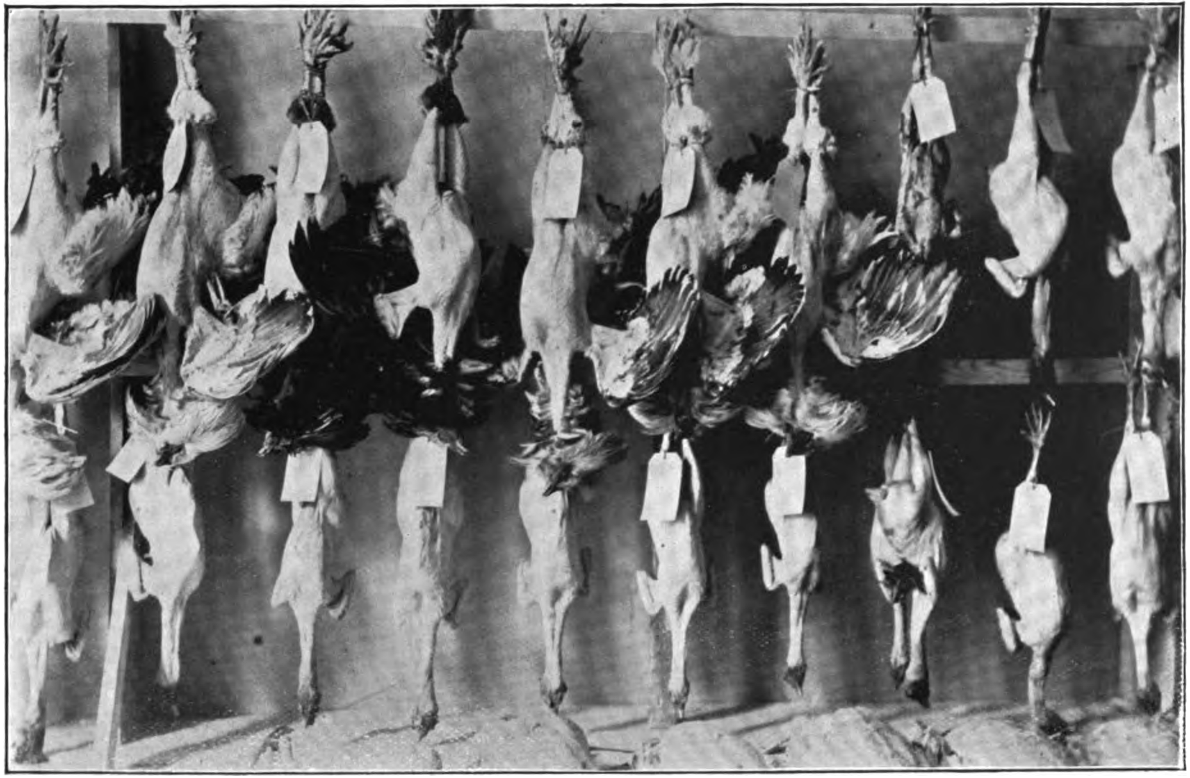
Purchasing birds here and there in making up a flock, may bring all sorts of diseases and parasites together, thus infecting a place at the start to such an extent that it is hard to get rid of them. Each new bird should be thoroughly examined for disease of any kind and treated for lice before being allowed to run with others. A few days quarantine is very desirable. Do not buy birds showing the slightest trace of disease. Avoid all that are suspicious, for a mild case of disease may introduce a serious trouble. Keep your flocks away from those of your neighbors, as a single infected fowl or turkey may infect a dozen or more different flocks, if allowed to run with them on common ground. Isolate your own stock from that of others as completely as possible. Do not feed uncooked offal. Entrails of animals are liable to contain parasites and germs of

disease that will affect fowls, therefore should be long and well cooked before being fed to any living thing. Do not feed milk from cows that are suspected of having tuberculosis. Do not allow persons having consumption to expectorate where they are. Every fowl which dies from any cause should be subjected to post mortem examination. Persons making such examination should make sure that the skin of their hands is not cut or abraded. This would make them liable to receive infectious matter that might result in blood poisoning. All instruments used in post mortem examinations should, as well as the hands, be afterwards cleansed in a solution of some antiseptic, like carbolic acid. By such examinations a disease may be discovered before it becomes very prevalent. It is best to sacrifice inferior and sickly specimens as they are usually the first to become infected and are apt to become disease breeders. Carcasses of diseased birds should be promptly buried, deep under ground, in a location remote from the haunts of fowls or animals, or better still, boiled or burned, that the infectious germs may be destroyed. Coops or buildings that have been occupied by them or the ground where they have lain, should be thoroughly sprayed or drenched with a solution of copperas or carbolic acid.

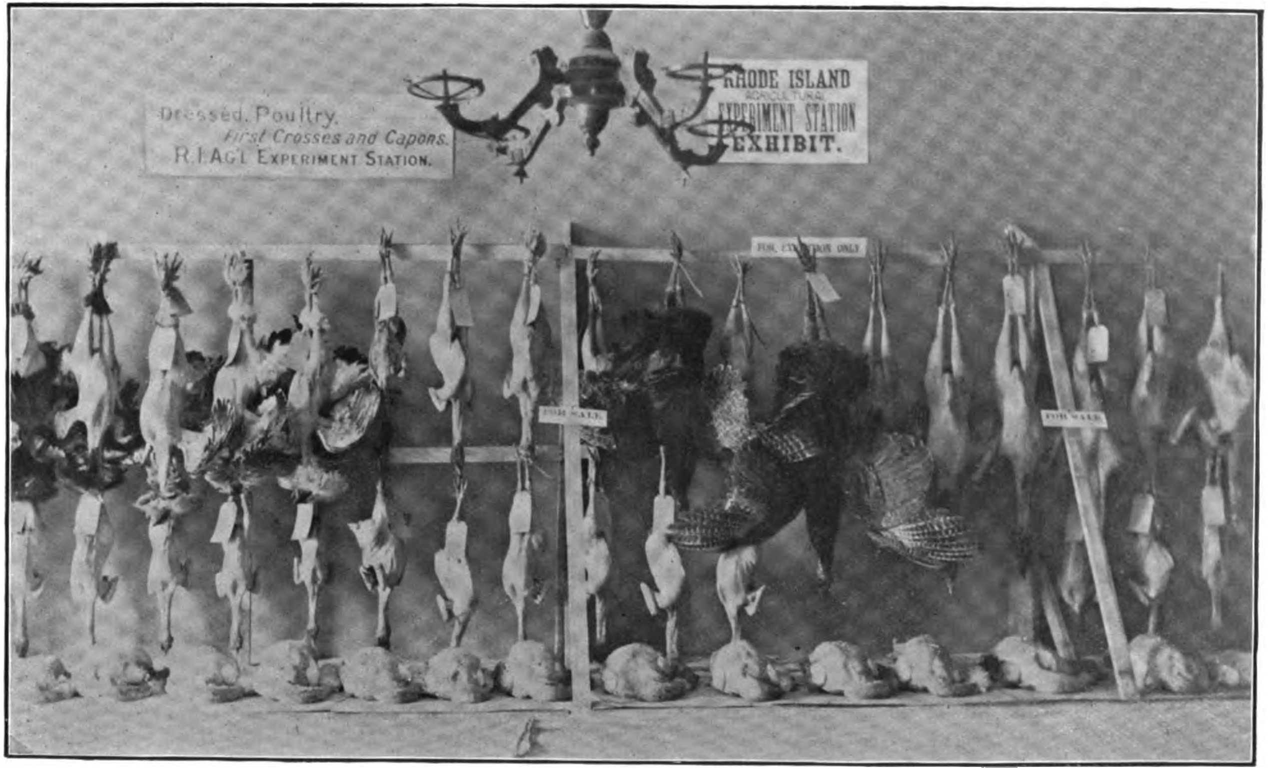
The great benefit in doctoring fowls whose worth is but a few dollars, lies principally in the preventive treatment of large numbers at one time. An early diagnosis of a disease makes this possible.

POULTRY STATISTICS OF THE NEXT STATE CENSUS.

Next year the State Census will be taken. The poultry statistics taken with the census have been in the past rather incomplete. It is very desirable, indeed very important, that statistics relating to all branches of the poultry industry should be collected. The public should know the magnitude of the business in this State, and whether as is often claimed, the money invested and products sold really do exceed those of any other live stock industry, and we would express the hope that the Commission having this mat-



Capons, first crosses, and Geese. Experiment Station Exhibit at the Winter Show of the R. I. Poultry Association.



First and second crosses, Capons, Turkeys and Geese. Experiment Station Exhibit at Winter Show of the R. I. Poultry Association.

ter in charge, will think it best to take measures to secure more complete statistics relating to poultry than were ever before collected.

THE RHODE ISLAND POULTRY ASSOCIATION.

By permission of the Board of Managers, considerable time was spent the latter part of the year in the interest of the Rhode Island Poultry Association. Its winter shows furnish us the best opportunity for placing the results of the work of this Division before those interested in poultry matters.

Although this Society has been in the past, a union of fanciers, those who raise beautiful birds for recreation or for profit, its exhibitions have done much for the practical poultry raisers of this State. To bring their choice productions before the public and make sales or advance the cause, fanciers have spent time and money in keeping up their annual shows. By causing pure bred fowls to be very generally kept, they have spread a knowledge of the proper care of poultry and have freely scattered material for the improvement of the common stock of the country. From this material the wide awake farmer and practical raiser has selected that really practical or profitable and discarded the tender or undesirable kinds. The great benefit that the poultry industry has thus received, can hardly be over-estimated. No branch of the poultry industry is independent of the others. All are dependent on the others. Market poultry raisers are indebted to fanciers, the fancier's business indirectly depends upon the use of pure bred fowls by farmers and practical poultry men. For this reason, public spirited citizens should cordially support Fancier's shows, and Poultry Societies should receive State aid. In a number of states annual grants are given to aid in holding exhibitions of poultry. The Poultry Association of Ontario receives yearly a Legislative Grant of $900, and the Eastern Ontario Poultry and Pet Stock Association receives $400. They hold their shows in different parts of the country, not in one place, year after year.

The Connecticut State Poultry Association receives this winter

$500 from the State to aid in holding a show at Hartford. The Rhode Island Poultry Association receives from this State an annual grant of $400 to pay premiums.

Doubtless these Exhibitions might be made of much greater benefit to the State, if features of more direct benefit to practical poultry men were made of as much importance as exhibitions of fancy fowls. Incubators and brooders of all kinds, in operation or simply on exhibition, would be of interest to intending purchasers, while exhibits of fine fowls, geese that are not of a pure breed, as well as extensive displays of eggs and dressed poultry of all kinds, if made annually, would be instructive and of great value to the public. A move in this direction has already been made by the Rhode Island Poultry Association, and at the last show as many as 274 specimens of dressed turkeys, geese, ducks and fowls were shown. No show in this country has had such a display in this line. Of live turkeys there were 91 specimens of high quality. The exhibitors sold many breeding turkeys. Many persons came long distances to see the turkeys and readily paid good prices. It is hoped that the Practical Department will be well supported by practical men and made more of a feature each year.

The State Board of Agriculture contributed very much to the success of this show by furnishing without charge, two prominent lecturers on poultry topics. The lectures were given in a hall near by, to which the general public were admitted free, and there was a large attendance.

METEOROLOGICAL SUMMARY FOR 1893.

N. HELME.

Highest temperature 92°, June 20th.
Lowest temperature 6°, January 11th.
Range of temperature for the year, 98°.
Mean temperature 46.5°.
Highest monthly mean 69°, July.
Lowest monthly mean 19.2°, January.
Highest daily mean 77.5°, July 18th.
Lowest daily mean 1.5°, January 11th.

Total precipitation for the year 57.33 inches.
Largest total for one month 9.44 inches, February.
Least total for one month .95 inch, July.
Total snowfall for the year 78 inches.
Largest amount of snow in one month 29 inches, February.
Smallest amount of snow in one month 8 inches, April.

Number of clear days in the year 126.
Number of fair days 130.
Number of cloudy days 109.
Number of days with precipitation of .01 inch or more, 131.

The total precipitation for each of the past five years, has been as follows: 1889, 64.54 inches; 1890, 59.25 inches; 1891, 49.88 inches; 1892, 42.58 inches; 1893, 57.33 inches; average, 54.51 inches.

The mean temperature of the past four years has been as fol-

lows: 1890, 48.3°; 1891, 49.4°; 1892, 47.8°; 1893, 46.5°; average, 48°.

A glance at the above will show that the rain fall of 1893 has been greatly in excess of that of 1891 and 1892. That of 1889 was very much above the normal which is about 45 inches.

Comparing each month of the year 1893 with the same one of 1892, the rain fall of January is nearly 2½ inches less than in 1892, that of February is five times as much as in 1892. March shows an excess of an inch; April 2½ inches; May ¾ of an inch; June 1½ inches; July shows a large deficiency, the rain fall being less than an inch, and only about one-third of that of 1892. August gave an increase of 2½ inches; September of a little more than an inch; October's is just double that of 1892, and November's a little less than one-half, while December is about 2⅝ times as much.

Making the same comparisons in temperature, January and February are both much colder than in 1892, the former 9.4° and the latter 3.8°. March is 0.2° warmer, April 3° colder, May 1° warmer, June 3° colder, July 1.3° colder, August shows a very slight change, September is 2.5° colder, October 3.3° warmer, November shows no change and December is 3.4° warmer. The mean temperature of the year was 1.5° less than the average for four years and is also slightly below the normal.

METEOROLOGICAL SUMMARY.

January 1st, 1890, to December 31st, 1893. Records daily at 7 A. M., 2 P. M. and 9 P. M.

	January.				February.				March.			
	1893.	1892.	1891.	1890.	1893.	1892.	1891.	1890.	1893.	1892.	1891.	1890.
Highest Barometer	30.34	30.60	30.45	30.56	30.63	30.58	30.18	30.40	30.58	30.67	30.52	30.35
Lowest Barometer	29.15	29.32	28.74	29.25	29.09	29.10	29.21	29.25	29.08	29.21	29.51	29.25
Mean Barometer	29.86	29.95	29.858	29.84	29.90	30.04	30 079	29.86	29.74	29.87	30.095	29.79
Highest Temperature	50.°	57.°	59.°	63.°	47.°	46.°	58.°	64.°	54.°	49.°	59.°	67.°
Lowest Temperature	-6.°	3.°	12.°	8.°	-1.°	4.°	5.°	10 °	8.°	12.°	1.°	5.°
Mean Temperature	19.2°	29.°	31.5°	36.4°	25.8°	29.2°	32.1°	35.2°	32.2°	32.7°	32.8°	38.5°
Prevailing Wind	S. W.	S. W.	S. W.	N. W.	S. W.	N. W.	S. W.	N. W.	W.	S. W.	N. W.	N. W.
Precipitation [rain or melted snow]	3.14 in.	5.39 in.	7.31 in.	3.02 in.	9.14 in.	1.72 in.	7.26 in.	3.30 in.	6.37 in.	4.09 in.	7.97 in.	9.83 in.
Number of Clear Days	11	7	4	8	9	8	2	7	11	12	14	4
Number of Fair Days	11	....	....	....	7	....	....	....	11	....	....	....
Number of Cloudy Days	9	12	15	15	12	18	11	14	9	17	7	10
Number of days with .01 inch or more of precipitation	12	10	9	11	12	5	6	13	12	6	5	16

EXPLANATORY NOTE.—In the tables the barometrical readings for 1891 and 1892 are reduced to sea level and temperature of 32°. The actual readings are given for the other years.

Cloudiness is estimated on a scale of 10. If the average of the three daily observations is three tenths or less cloudy, the day is clear; from four to seven tenths, fair, and eight to ten tenths, cloudy.

METEOROLOGICAL SUMMARY.—CONTINUED.

January 1st, 1890, to December 31st, 1893. Records daily at 7 A. M., 2 P. M. aud 9 P. M.

	APRIL.				MAY.				JUNE.			
	1893.	1892.	1891.	1890.	1893.	1892.	1891.	1890.	1893.	1892.	1891.	1890.
Highest Barometer	30.40	30.47	30.52	30.33	30.12	30.46	30.47	30.17	30.13	30.38	30.16	30.20
Lowest Barometer	29.35	29.33	28.94	29.30	29.12	29.39	29.68	29.58	29.50	29.61	29.62	29.67
Mean Barometer	29.87	29.95	29.875	29.86	29.72	29.98	29.951	29.85	29.85	29.94	29.899	29.89
Highest Temperature	64.°	76.°	76.°	70.°	82.°	76.°	79.°	77.°	92.°	90.°	92.°	96.°
Lowest Temperature	23.°	25.°	20.°	24.°	36.°	38.°	30.°	36.°	46.°	41.°	42.°	54.°
Mean Temperature	42.8°	54.°	44.9°	44.7°	54.8°	54.°	53.1°	54.1°	63.5°	66.°	63.6°	63.9°
Prevailing Wind	W.	S. W.	S. W.	S. W.	W.	S. W.	S. W.	S. W.	E.	S. W.	S. W.	S. W.
Precipitation [rain or melted snow]	5.98 in.	3.30 in.	4.70 in.	4.27 in.	6.12 in.	6.09 in.	1.76 in.	4.72 in.	3.92 in.	1.61 in.	.70 in.	3.96 in.
Number of Clear Days	9	14	15	11	12	5	14	10	6	9	13	10
Number of Fair Days	8	....	....	....	6	....	....	....	11	....	....	....
Number of Cloudy Days	13	15	4	5	13	24	5	9	13	21	7	10
Number of days with .01 inch or more of precipitation	12	7	8	10	11	14	5	11	9	6	8	8

METEOROLOGICAL SUMMARY.—CONTINUED.

January 1st, 1890, to December 31st, 1893. Records daily at 7 A. M., 2 P. M. and 9 P. M.

	JULY.				AUGUST.				SEPTEMBER.			
	1893.	1892.	1891.	1890.	1893.	1892.	1891.	1890.	1893.	1892.	1891.	1890.
Highest Barometer.	30.02	30.39	30.35	30.20	30.05	30.20	30.22	....	30.20	30.46	30.36	30.25
Lowest Barometer.	29.45	29.42	29.70	29.69	29.40	29.74	29.95	....	29.48	29.51	29.67	29.55
Mean Barometer.	29.78	29.27	29.896	29.692	29.82	29.94	29.63	....	29.84	30.10	30.084	30.01
Highest Temperature	91.°	91.°	83.°	92.°	87.°	89.°	91.°	85.°	76.°	75.°	82.°	80.°
Lowest Temperature	48.°	47.°	40.°	47.°	48.°	56.°	48.°	38.°	40.°	41.°	48.°	34.°
Mean Temperature	69.°	70.4°	65.6°	69 1°	68.8°	68.4°	69.3°	66.9°	58.3°	60.4°	64.3°	61.4°
Prevailing Wind	W.	S. W.	S. W.	S. W.	W.	S. W.	S. W.	S. W.	N. W.	S. W.	S. W.	S. W.
Precipitation [rain or melted snow]	.95 in.	3.43 in.	2.11 in.	1.88 in.	5.74 in.	2.96 in.	2.69 in.	3.89 in.	3.76 in.	2.48 in.	2.20 in.	3.93 in.
Number of Clear Days	14	6	11	9	12	5	6	2	12	11	9	9
Number of Fair Days	12	....	....	....	10	....	....	....	12	....	....	....
Number of Cloudy Days	5	20	12	5	9	22	5	10	6	15	8	14
Number of days with .01 inch or more of precipitation	9	9	6	7	12	6	10	9	10	5	6	10

METEOROLOGICAL SUMMARY.—CONTINUED.

January 1st, 1890, to December 31st, 1893. Records daily at 7 A. M., 2 P. M. and 9 P. M.

	OCTOBER.				NOVEMBER.				DECEMBER.			
	1893.	1892.	1891.	1890.	1893.	1892.	1891.	1890.	1893.	1892.	1891.	1890.
Highest Barometer	30.37	30.40	30.51	30.19	30.40	30.38	30.71	30.12	30.52	30.45	30.46	30.44
Lowest Barometer	29.30	29.45	29.48	29.12	29.42	29.58	29.48	29.50	29.28	29.38	29.34	29.27
Mean Barometer	29.92	29.89	29.986	29.73	29.89	29.98	30.117	29.78	29.87	29.92	30.053	29.868
Highest Temperature	72.°	76.°	78.°	75.°	67.°	64.°	62.°	67.°	58.°	53.°	65.°	52.°
Lowest Temperature	27.°	30.°	20.°	32.°	15.°	18.°	9.°	14.°	0.°	0.°	7.°	1.°
Mean Temperature	53.2°	50.27°	49.7°	49.8°	40.1°	40.23°	40.8°	41.3°	31.°	28.8°	39.5°	27.3°
Prevailing Wind	N. W.	S. W.	S. W.	N. E.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.	N. W.
Precipitation [rain or melted snow]	3.02 in.	1.64 in.	6.72 in.	9.43 in.	3.37 in.	6.20 in.	2.99 in.	.96 in.	5.52 in.	2.02 in.	3.78 in.	4.71 in.
Number of Clear Days	11	10	9	8	9	7	10	11	10	8	9	12
Number of Fair Days	14	....	....	....	15	....	....	....	13	....	....	....
Number of Cloudy Days	6	17	8	15	6	21	10	5	8	22	8	10
Number of days with .01 inch or more of precipitation	6	5	7	16	10	7	8	3	16	9	10	6

EXCHANGES AND DONATIONS.

Copies of the following Agricultural and other papers have been regularly received at this Office, where they are kept on file for reference:

The Baltimore Sun, Baltimore, Md.
Mirror and Farmer, Manchester, N. H.
The National Provisioner, New York, N. Y.
The Holstein Friesian Register, Boston, Mass.
The Toledo News, Toledo, Ohio.
The Industrial American, Lexington, Ky.
The Practical Farmer, Philadelphia, Pa.
The American Agriculturist, New York, N. Y.
The Louisiana Planter, New Orleans, La.
The Southern Cultivator and Dixie Farmer, Atlanta, Ga.
Home and Farm, Louisville, Ky.
The Sugar Beet, Philadelphia, Pa.
The Pomona Herald, Providence, R. I.
Sentinel Advertiser, Hope Valley, R. I.
The New Dairy, New York, N. Y.
The University Record, Ann Arbor, Mich.
The Naturalist's Leisure Hour, Philadelphia, Pa.
The Agricultural Epitomist, Indianapolis, Ind.
The American Cultivator, Boston, Mass.
The American Horse Breeder, Boston and New York.
Western Farmer and Stockman, Sioux City, Iowa.
The American Grange Bulletin and Scientific Farmer, Cincinnati, Ohio.

Hoard's Dairyman, Fort Atkinson, Wisconsin.

Farm, Field and Fireside, Chicago, Ill.

Numerous reports and publications of the U. S. Government Department of Agriculture and other Departments have been received, as well as all bulletins and reports from all the Experiment Stations in the United States, and some from Canada and New South Wales.

Reports have also been received from City and State Boards of Agriculture, Societies, etc.

REPORT OF THE TREASURER.

The Rhode Island State Agricultural Experiment Station in account with the United States Appropriation.

DR.

1893.	To receipts from the Treasurer of the United States as per appropriation for the year ending June 30, 1893, under Act of Congress approved March 2, 1887......		$15,000 00

CR.

June 30.	By Salaries..................................	$7,888 40	
	Labor..................................	2,620 07	
	Supplies and repairs....................	1,090 91	
	Freight, express, postage and stationery	328 18	
	Library and printing..................	1,143 53	
	Tools and machinery	484 37	
	Chemical apparatus and supplies........	273 31	
	Furniture and general fittings..........	151 00	
	Live stock............................	168 25	
	Travelling............................	338 42	
	Incidentals............................	55 22	
	Buildings..............................	458 34	
		$15,000 00	$15,000 00

This certifies that we, the undersigned, authorized auditing committee of the Board of Managers of the Rhode Island College of Agriculture and Mechanic Arts, have examined the accounts of the Treasurer of the Agricultural Experiment Station for the fiscal year, ending June 30, 1893, and that we find

the receipts for the time named to have been $15,000, and that the same has been expended, for which satisfactory vouchers, correctly classified as above, are on file, and the same agree with the Treasurer's account, and that there is no unexpended balance.

CHAS. O. FLAGG, } *Auditing*
CHAS. J. GREENE, } *Committee.*

I hereby certify that the above is a true copy from the books of account of the institution named.

MELVILLE BULL,
Treasurer of the Rhode Island College of Agriculture and Mechanic Arts.

I hereby certify that the above signature is that of the Treasurer of the Rhode Island College of Agriculture and Mechanic Arts.

CHAS. O. FLAGG,
President Board of Managers of the Rhode Island College of Agriculture and Mechanic Arts.

Melville Bull, Treasurer, in account with the Rhode Island Agricultural Experiment Station.

DR.

1893.		
June 30.	To Balance from last year	$106 99
	Farm receipts	976 15
	State "	1,520 99
	Interest	54 51
		$2,658 64

CR.

	By Labor	$584 70
	Supplies and repairs	1,550 00
	Fertilizer inspection	365 35
	Incidentals	150 00
	Balance on hand	8 59
		$2,658 64

DR.

1893.		
June 30.	To balance of funds received from the Treasurer of the United States as per appropriation made by special Act of Congress on April 4, 1890	$2,788 24
	Interest on above	120 57
		$2,908 81

CR.

1893.		
June 30.	By Labor	$1,049 85
	Supplies and repairs	43 12
	Library and printing	174 14
	Tools and machinery	2 63
	Balance unexpended	1,639 07
		$2,908 81

This is to certify that the undersigned, auditing committee of the Board of Managers of the Rhode Island College of Agriculture and Mechanic Arts, have examined the accounts of Melville Bull, Treasurer, ending June 30, 1893, and the vouchers corresponding therewith, and find the same correct.

CHAS. O. FLAGG, } *Auditing*
C. H. COGGESHALL, } *Committee.*

BULLETINS

AND

ANNUAL REPORT

OF THE

RHODE ISLAND

Agricultural Experiment Station,

FOR THE

YEAR 1893.

PROVIDENCE:
E. L. FREEMAN & SON, STATE PRINTERS.
1895.

INDEX

OF THE

BULLETINS AND ANNUAL REPORT

OF THE

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION,

FOR THE YEAR 1893.

NOTE:—For pp. 1-37 see Bul. 21; pp. 38-58 see Bul. 22; pp. 59-76 see Bul. 23; pp. 77-83 see Bul. 24; pp. 84-123 see Bul. 25; pp. 124-156 see Bul. 26.

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State of Rhode Island and Providence Plantations.

SIXTH ANNUAL REPORT

OF THE

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION,

1893.

PART II

OF THE

SIXTH ANNUAL REPORT

OF THE

BOARD OF MANAGERS

OF THE

Rhode Island College of Agriculture and Mechanic Arts,

MADE TO THE

GENERAL ASSEMBLY AT ITS JANUARY SESSION, 1894.

[PART I OF THIS REPORT—COLLEGE CATALOGUE—IS PRINTED UNDER SEPARATE COVER.]

PROVIDENCE, R. I.
E. L. FREEMAN & SON, PRINTERS TO THE STATE.
1894.